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Ober

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(54) **ATMOSPHERIC STORAGE MECHANICAL WEIGHT BATCH BLENDING PLANT**

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(51) **Int. Cl.**

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B28C 7/06 (2006.01)
B28C 9/02 (2006.01)
C04B 28/02 (2006.01)
C09K 8/46 (2006.01)

(52) **U.S. Cl.**

CPC ***B28C 7/0422*** (2013.01); ***B28C 7/0418*** (2013.01); ***B28C 7/062*** (2013.01); ***B28C 9/02*** (2013.01); ***C04B 28/02*** (2013.01); ***C09K 8/46*** (2013.01)

(58) **Field of Classification Search**

CPC B28C 7/0422
USPC 366/18, 20, 141, 64–66
See application file for complete search history.

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Primary Examiner — David Sorkin
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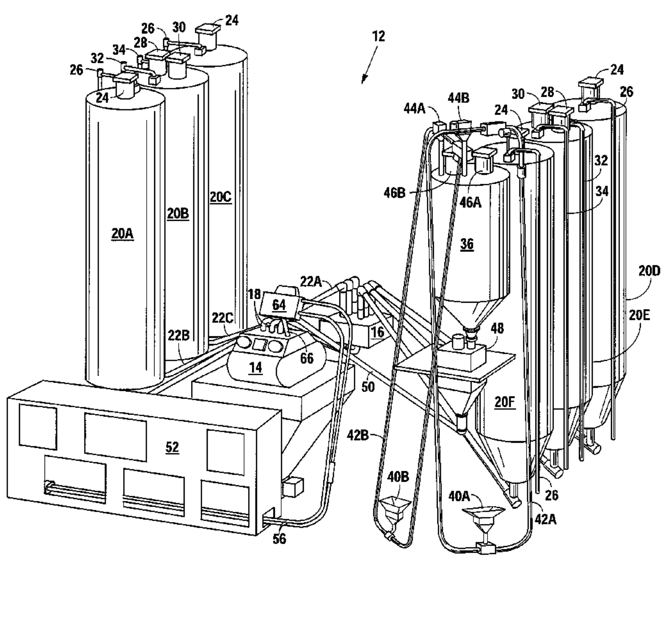
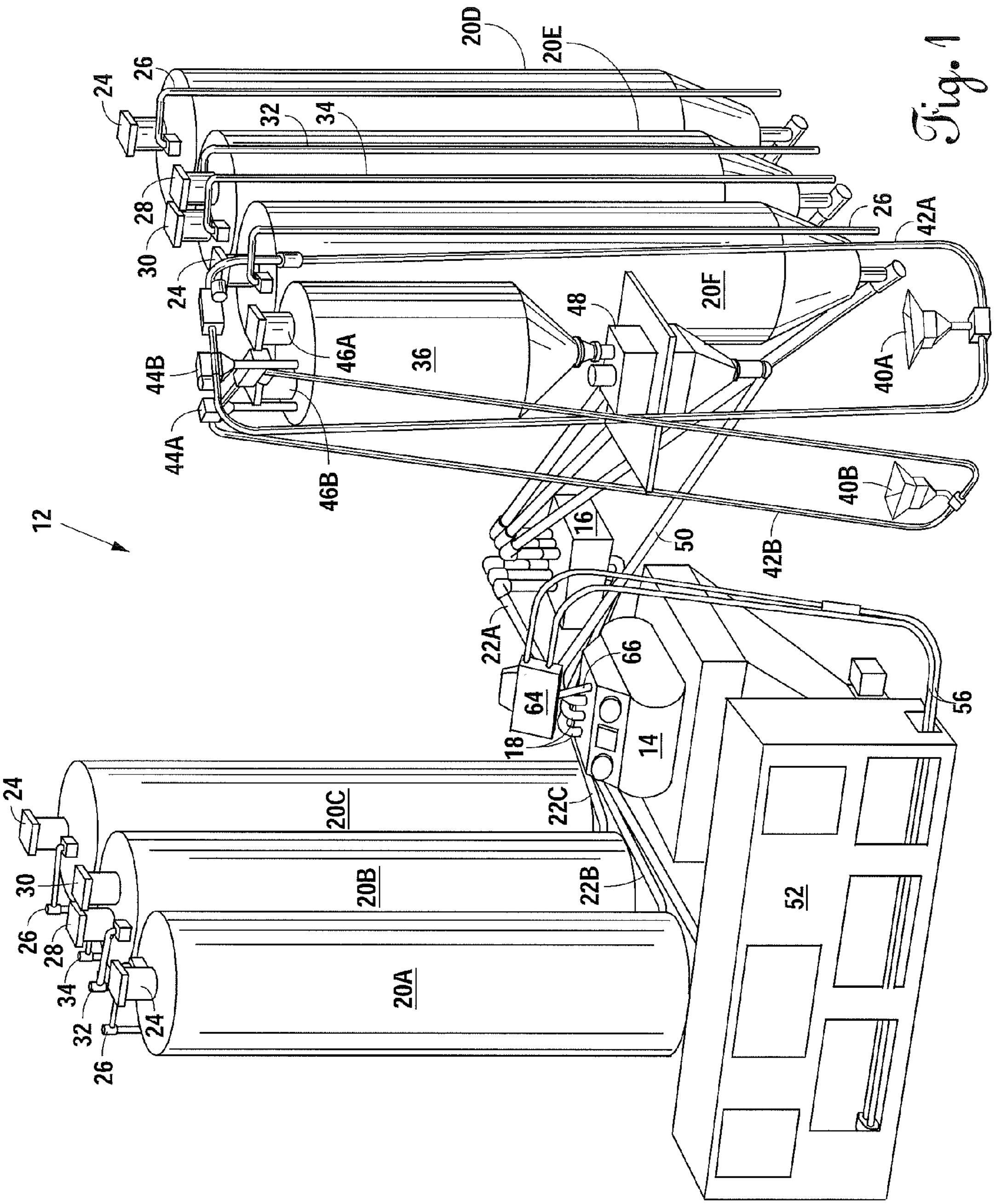
(57) **ABSTRACT**

An atmospheric storage mechanical weigh batch blend plant is shown with atmospheric storage for providing a dry, pre-blend, oilfield cement ready for mixing at the wellhead for slurry injection into a well head upon adding the proper amount of water and other fluids. The batch blend plant has three separate weighing mechanisms for (a) larger or bulk quantity materials, (b) intermediate quantities of materials, and (c) small amounts of additives to be included to the mixture. The entire weigh batch blend plant can be disassembled and moved. A special pressurized air bearing is used in the blender.

10 Claims, 19 Drawing Sheets

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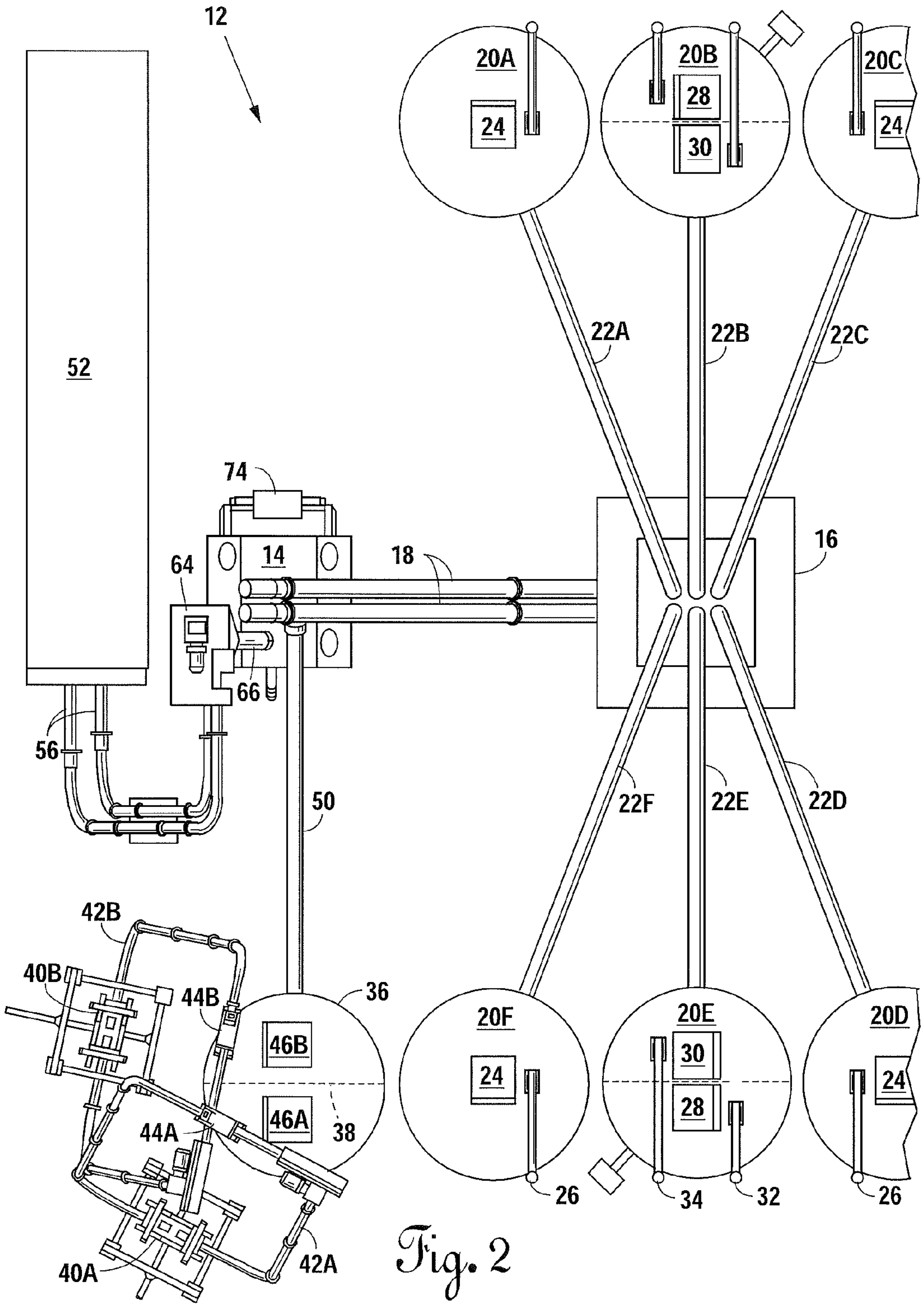
20A
20B
20C
20D
20E
20F
22A
22B
22C
24
26
28
30
32
34
36
40A
40B
42A
42B
44A
44B
46A
46B
48
50
52
56
64
66
14
16
18

Fig. 1


12
52
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20A
20B
20C
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22A
22B
22C
22F
22E
22D
42B
40B
44B
36
46B
46A
44A
38
20F
20E
20D
24
30
28
24
26
34
32
26
42A
40A

Fig. 2

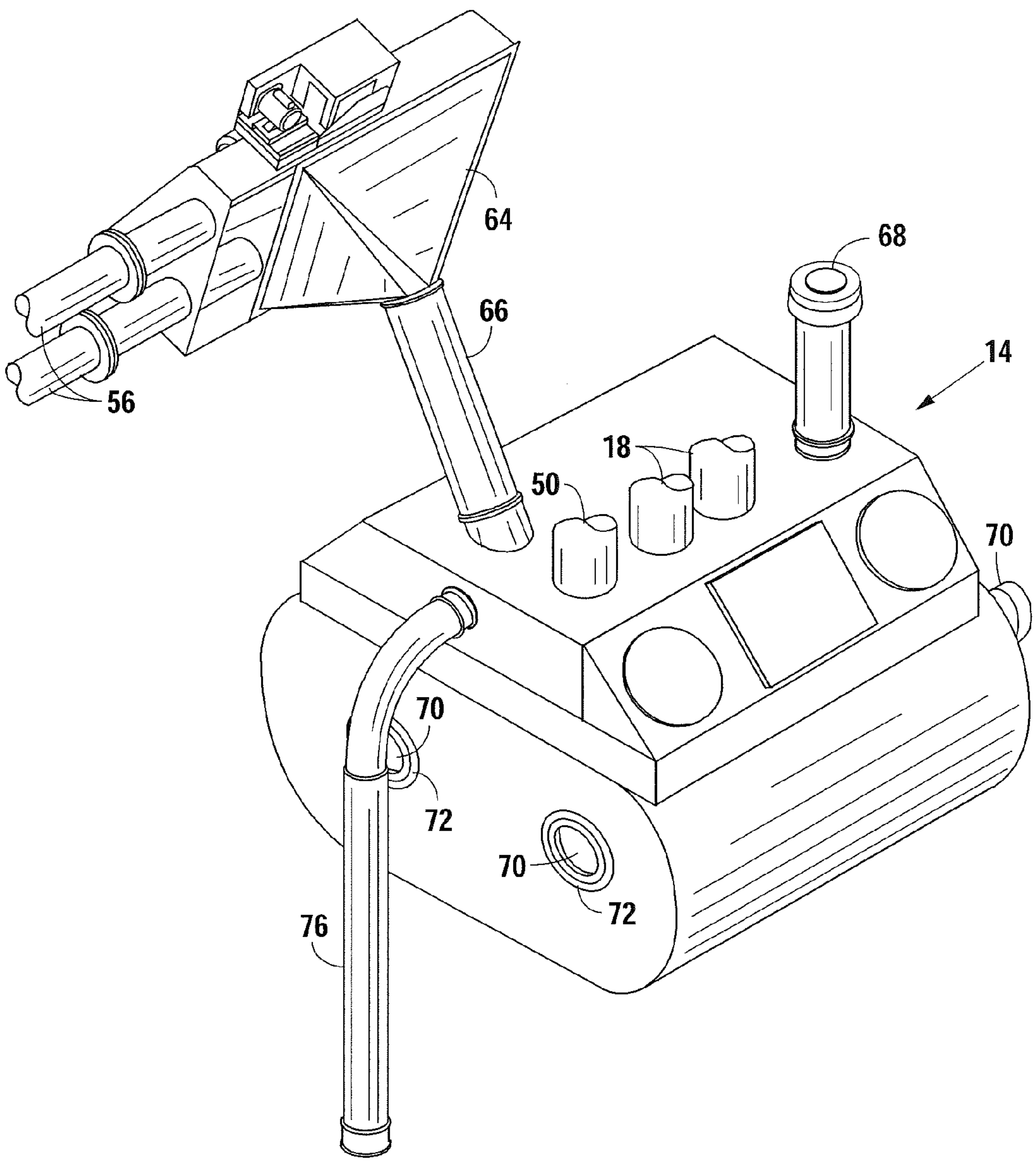


Fig. 3

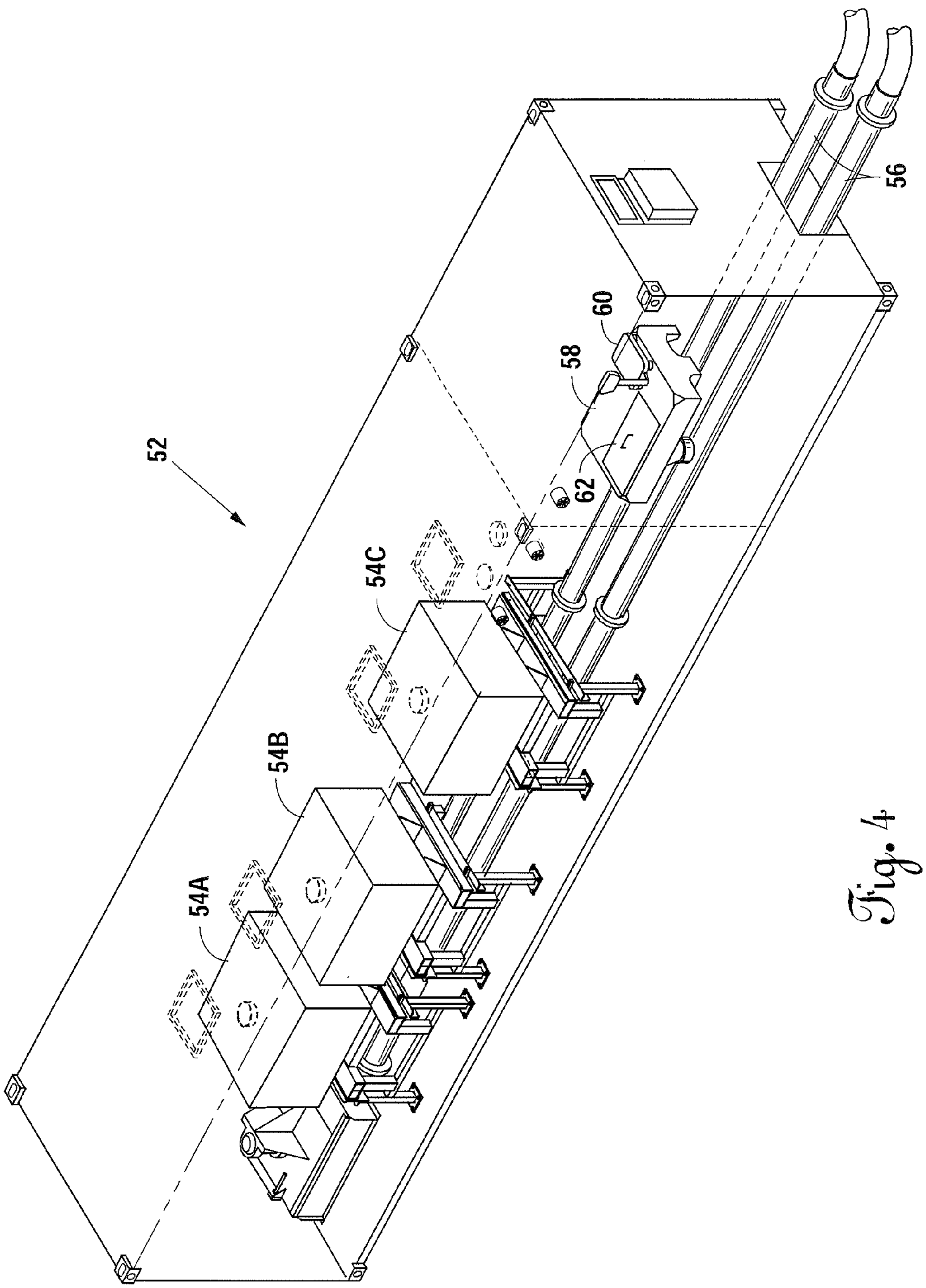


Fig. 4

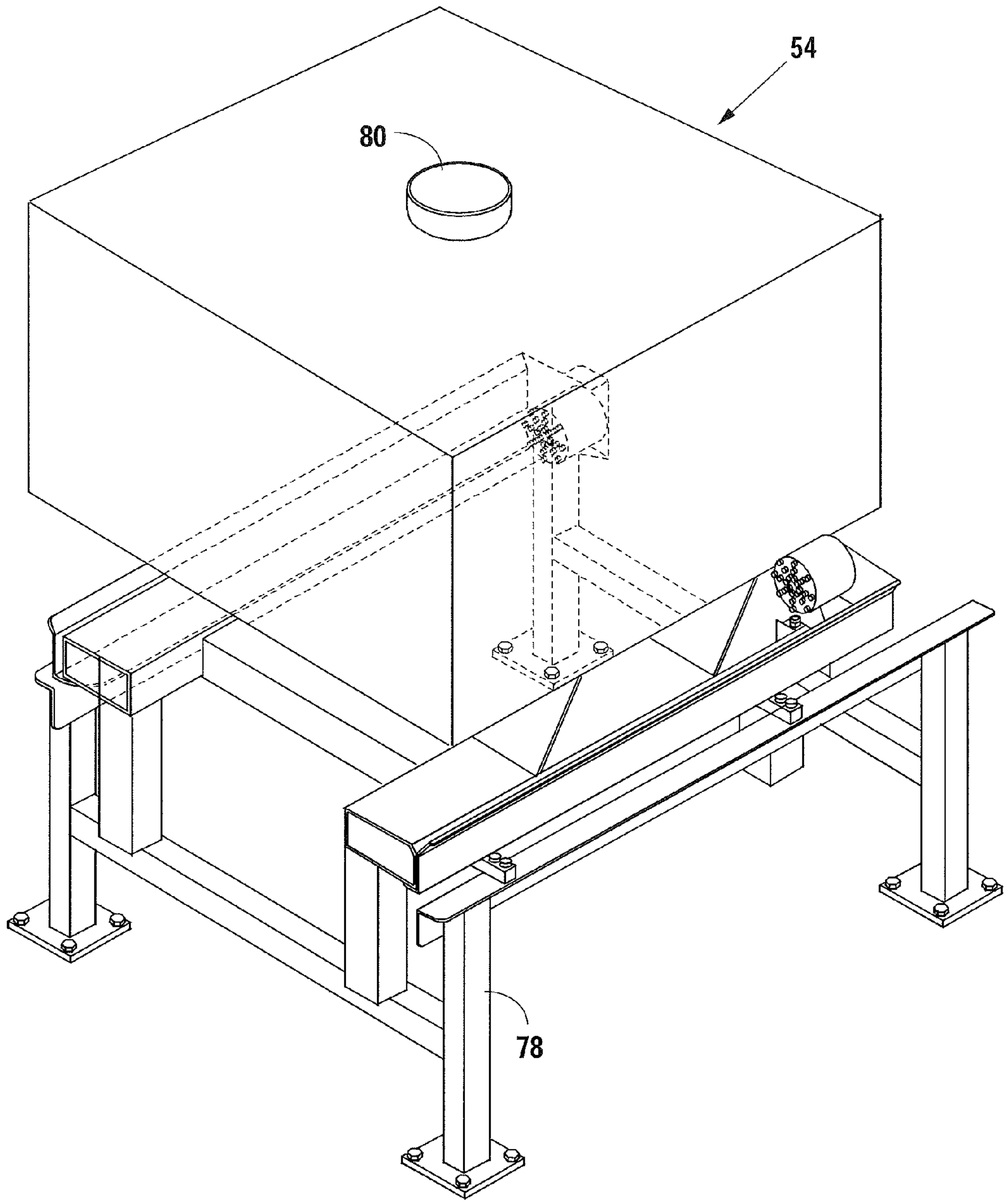


Fig. 5

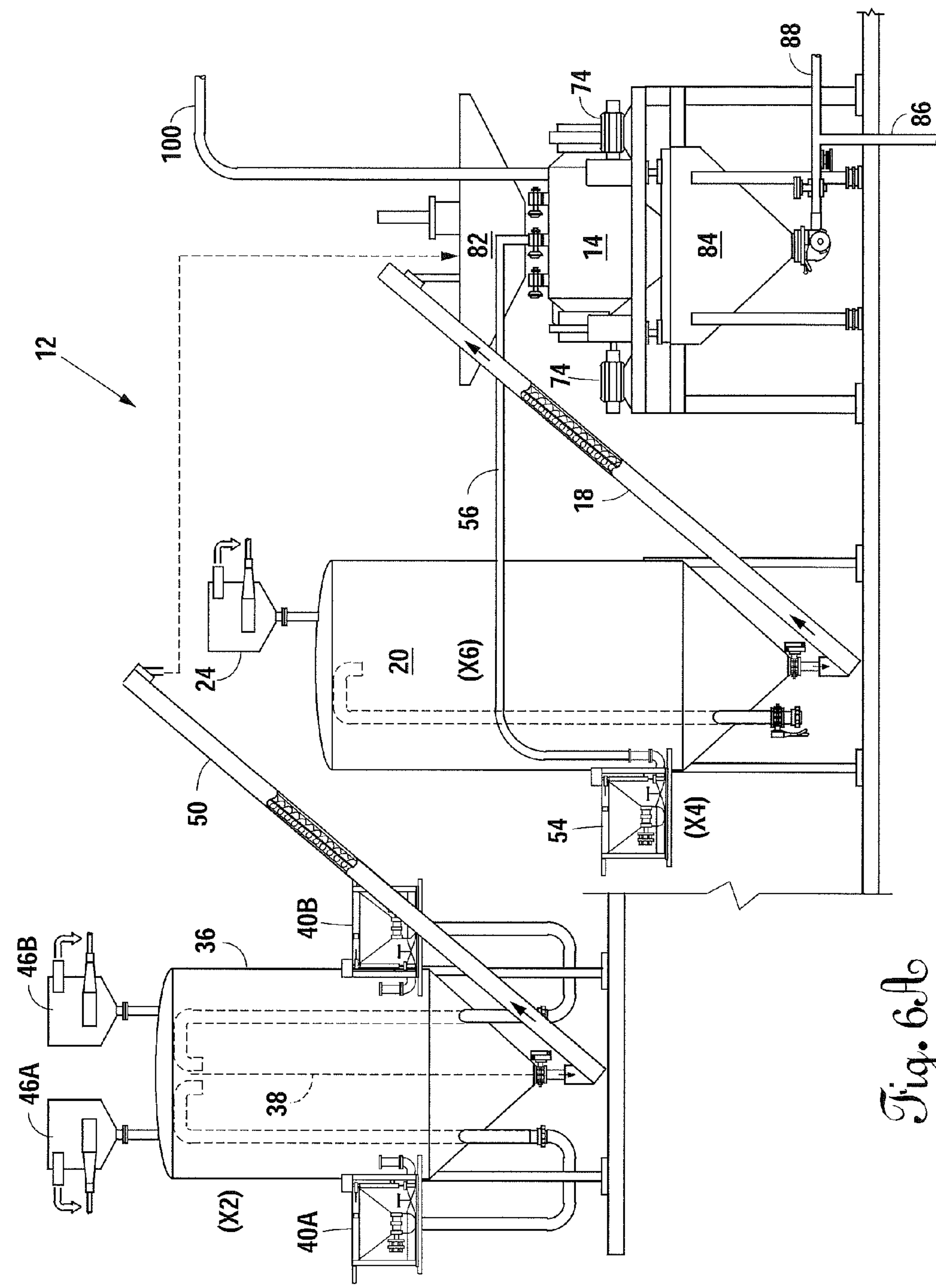
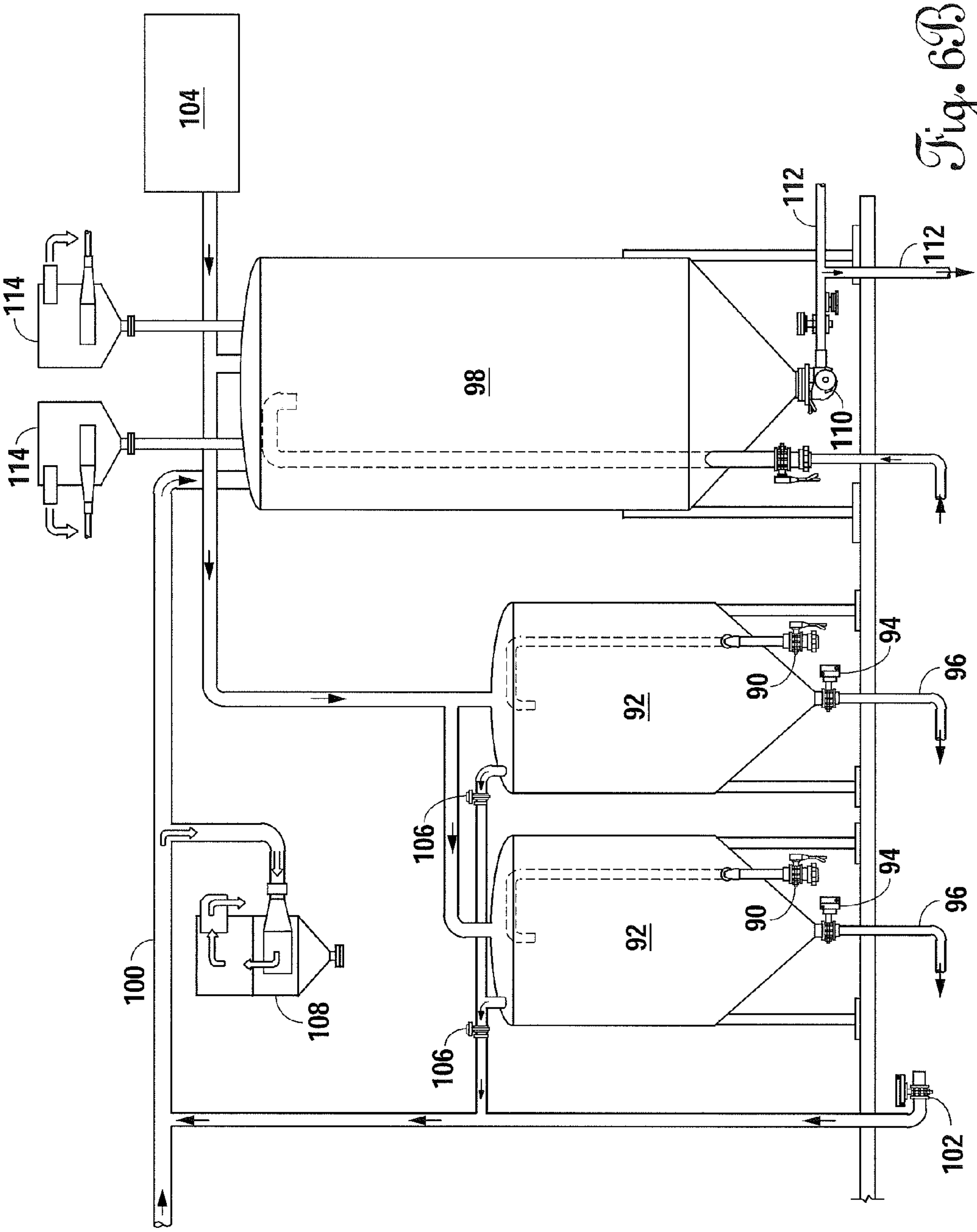

12
100
74
88
86
82
14
84
74
56
18
24
20
(X6)
50
54
(X4)
46B
46A
36
40B
38
(X2)
40A

Fig. 6A


104
114
114
98
112
112
110
100
108
106
106
92
92
90
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94
94
96
96
102

Fig. 6B

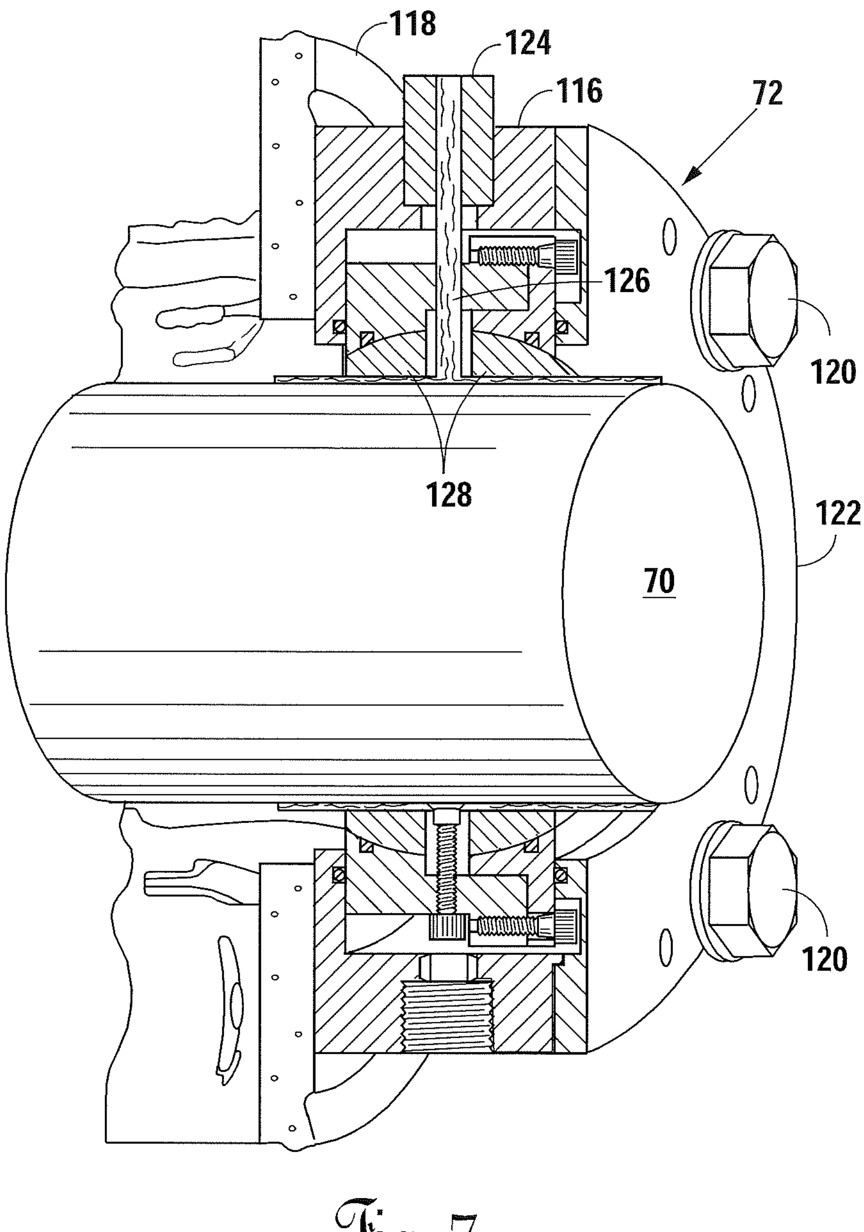

Fig. 7

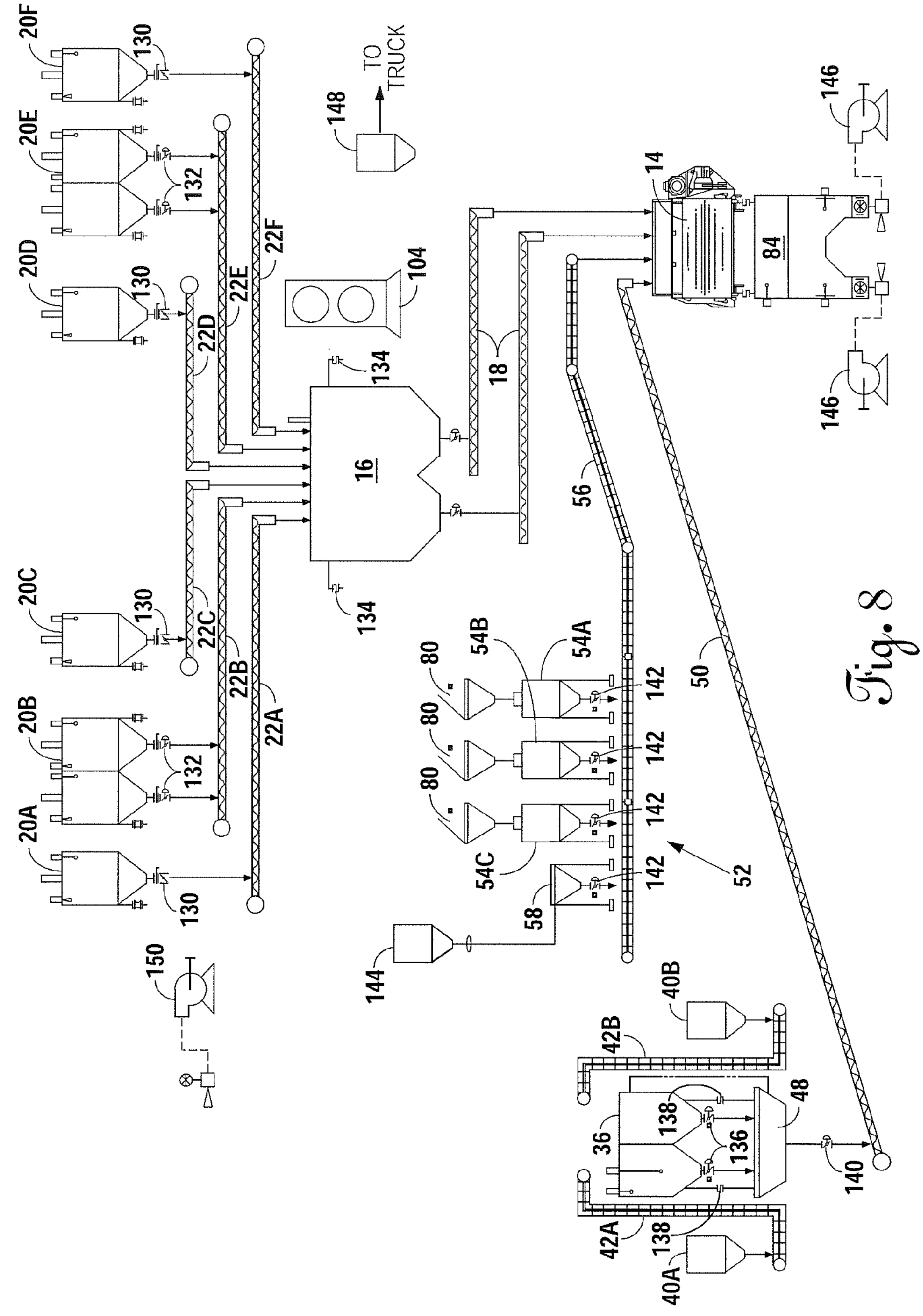
20A
20B
20C
20D
20E
20F
22A
22B
22C
22D
22E
22F
130
132
134
16
18
14
84
104
148
TO TRUCK
146
150
56
50
52
54A
54B
54C
58
80
142
144
36
40A
40B
42A
42B
48
136
138
140

Fig. 8

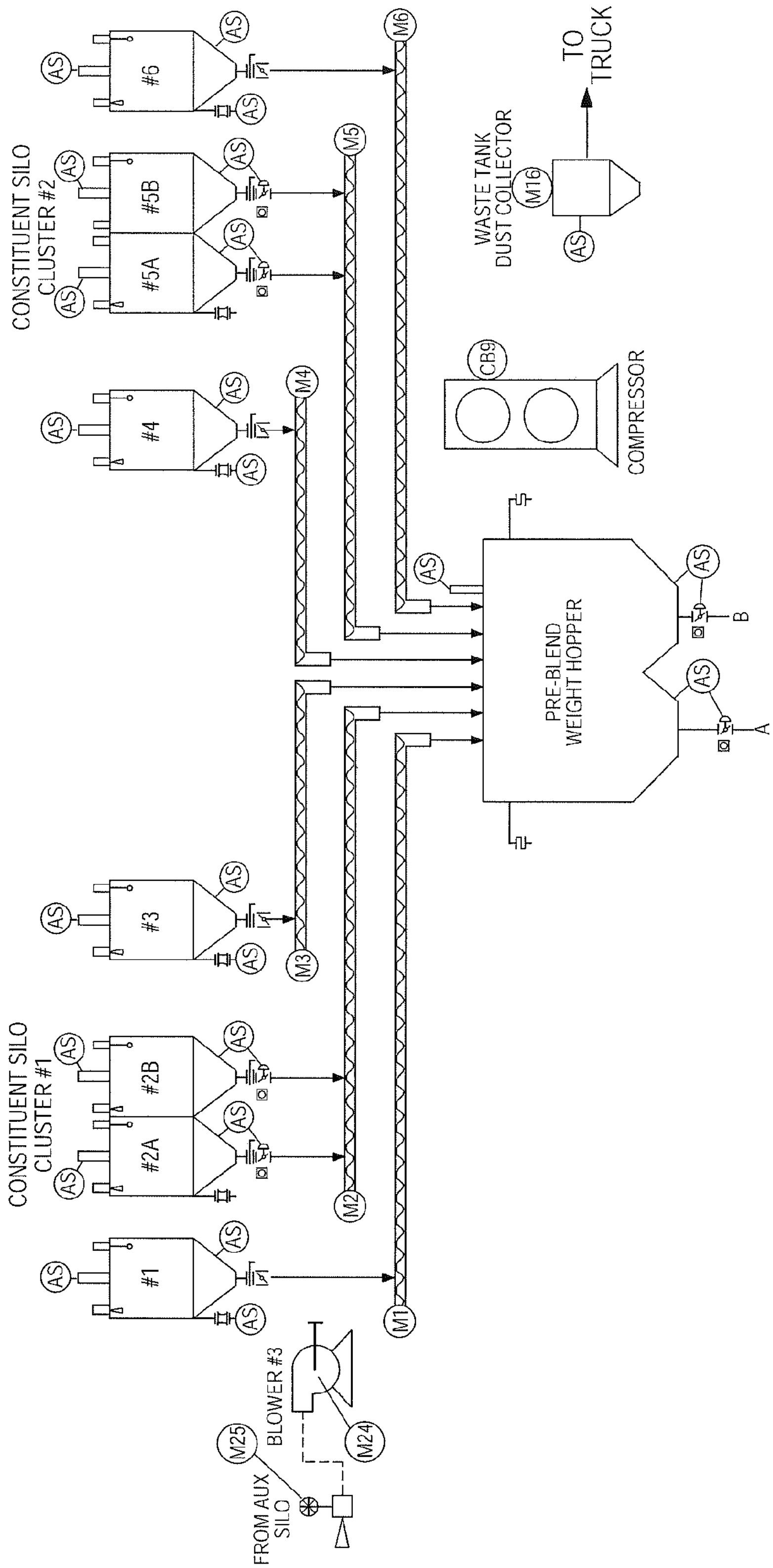
CONSTITUENT SILO
CLUSTER #2
#6
#5B
#5A
#4
#3
#2B
#2A
#1
CONSTITUENT SILO
CLUSTER #1
AS
M1
M2
M3
M4
M5
M6
TO
TRUCK
WASTE TANK
DUST COLLECTOR
M16
CB9
COMPRESSOR
PRE-BLEND
WEIGHT HOPPER
A
B
BLOWER #3
M24
M25
FROM AUX
SILO

Fig. 8a

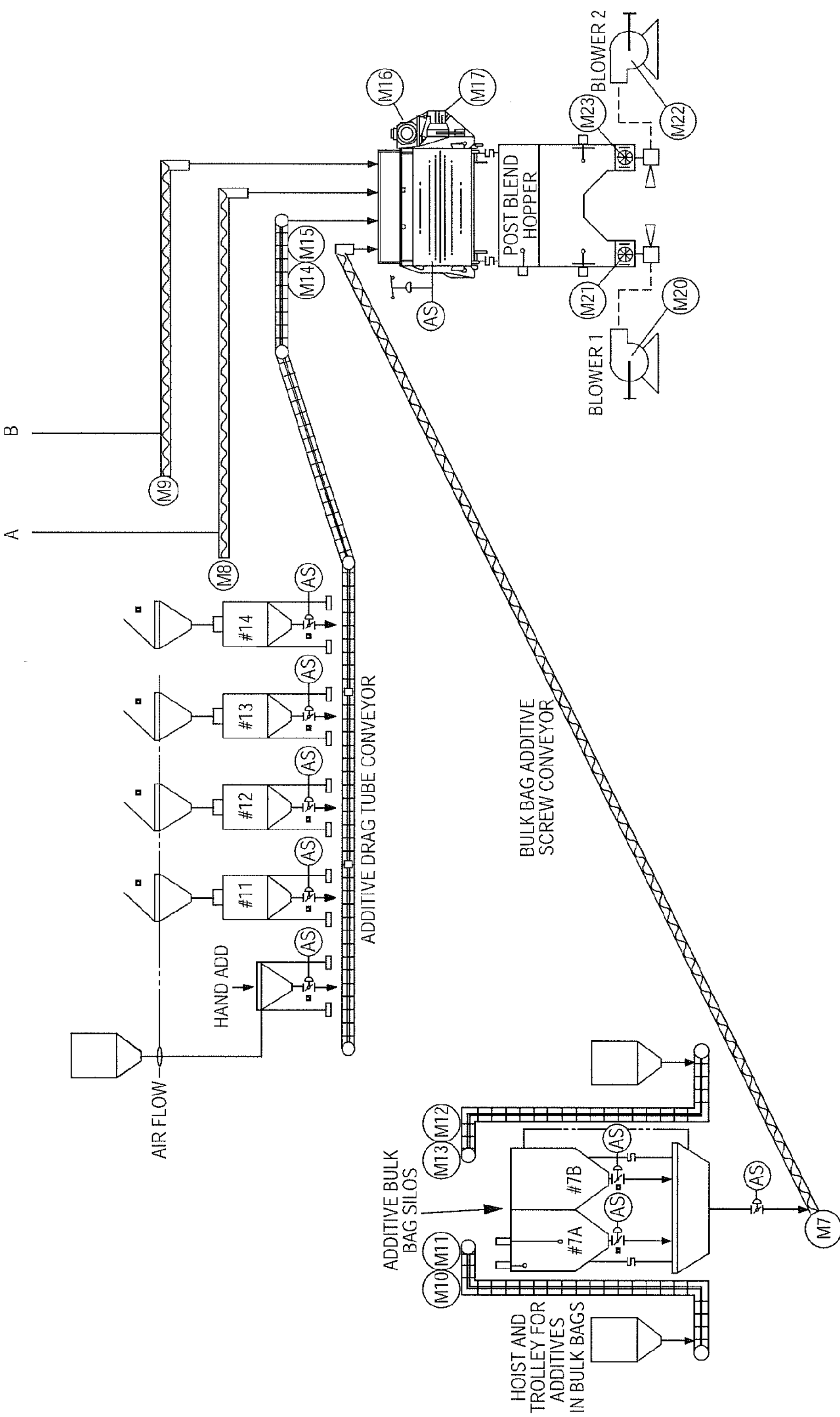
B
A
M9
M8
M16
M17
M23
M22
BLOWER 2
POST BLEND HOPPER
M21
M20
BLOWER 1
AS
M14
M15
#14
#13
#12
#11
HAND ADD
AIR FLOW
ADDITIVE DRAG TUBE CONVEYOR
BULK BAG ADDITIVE SCREW CONVEYOR
ADDITIVE BULK BAG SILOS
M13
M12
M10
M11
#7B
#7A
M7
HOIST AND TROLLEY FOR ADDITIVES IN BULK BAGS

Fig. 8b

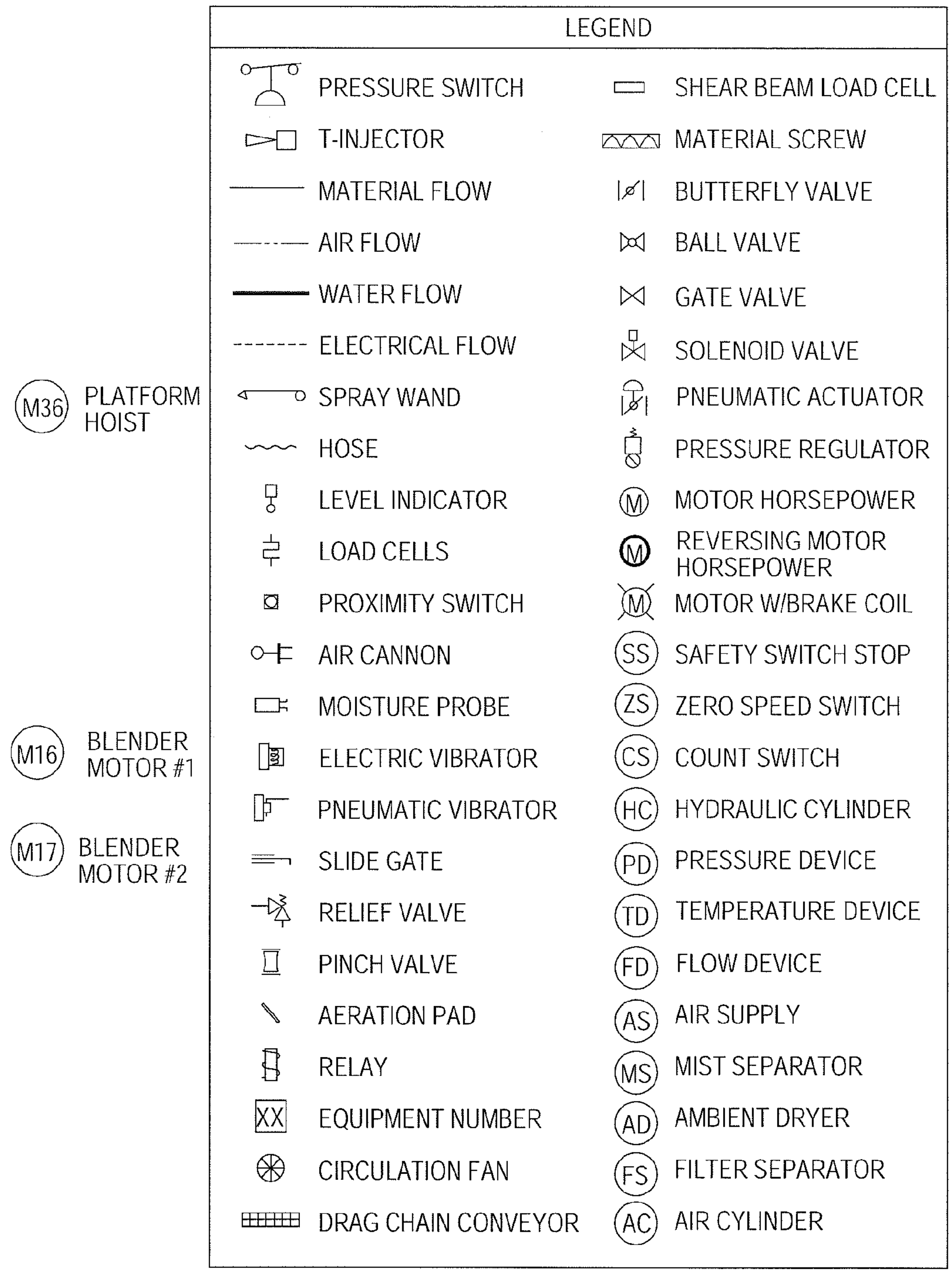
M36 PLATFORM HOIST
M16 BLENDER MOTOR #1
M17 BLENDER MOTOR #2
LEGEND
PRESSURE SWITCH
T-INJECTOR
MATERIAL FLOW
AIR FLOW
WATER FLOW
ELECTRICAL FLOW
SPRAY WAND
HOSE
LEVEL INDICATOR
LOAD CELLS
PROXIMITY SWITCH
AIR CANNON
MOISTURE PROBE
ELECTRIC VIBRATOR
PNEUMATIC VIBRATOR
SLIDE GATE
RELIEF VALVE
PINCH VALVE
AERATION PAD
RELAY
XX EQUIPMENT NUMBER
CIRCULATION FAN
DRAG CHAIN CONVEYOR
SHEAR BEAM LOAD CELL
MATERIAL SCREW
BUTTERFLY VALVE
BALL VALVE
GATE VALVE
SOLENOID VALVE
PNEUMATIC ACTUATOR
PRESSURE REGULATOR
M MOTOR HORSEPOWER
M REVERSING MOTOR HORSEPOWER
M MOTOR W/BRAKE COIL
SS SAFETY SWITCH STOP
ZS ZERO SPEED SWITCH
CS COUNT SWITCH
HC HYDRAULIC CYLINDER
PD PRESSURE DEVICE
TD TEMPERATURE DEVICE
FD FLOW DEVICE
AS AIR SUPPLY
MS MIST SEPARATOR
AD AMBIENT DRYER
FS FILTER SEPARATOR
AC AIR CYLINDER

Fig. 8c

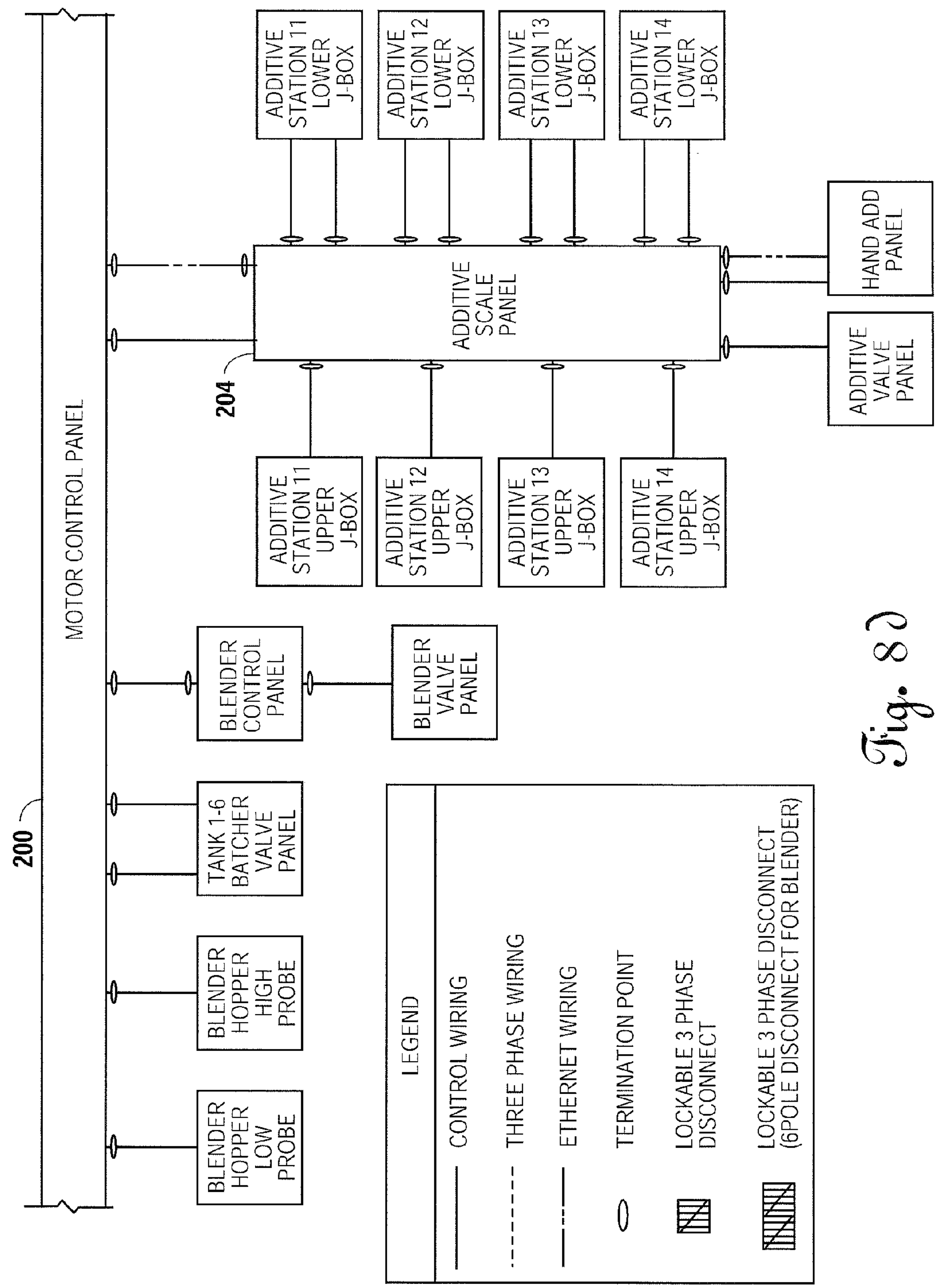
MOTOR CONTROL PANEL
200
204
BLENDER HOPPER LOW PROBE
BLENDER HOPPER HIGH PROBE
TANK 1-6 BATCHER VALVE PANEL
BLENDER CONTROL PANEL
BLENDER VALVE PANEL
ADDITIVE SCALE PANEL
ADDITIVE STATION 11 LOWER J-BOX
ADDITIVE STATION 12 LOWER J-BOX
ADDITIVE STATION 13 LOWER J-BOX
ADDITIVE STATION 14 LOWER J-BOX
ADDITIVE STATION 11 UPPER J-BOX
ADDITIVE STATION 12 UPPER J-BOX
ADDITIVE STATION 13 UPPER J-BOX
ADDITIVE STATION 14 UPPER J-BOX
HAND ADD PANEL
ADDITIVE VALVE PANEL
LEGEND
CONTROL WIRING
THREE PHASE WIRING
ETHERNET WIRING
TERMINATION POINT
LOCKABLE 3 PHASE DISCONNECT
LOCKABLE 3 PHASE DISCONNECT (6POLE DISCONNECT FOR BLENDER)

Fig. 8D

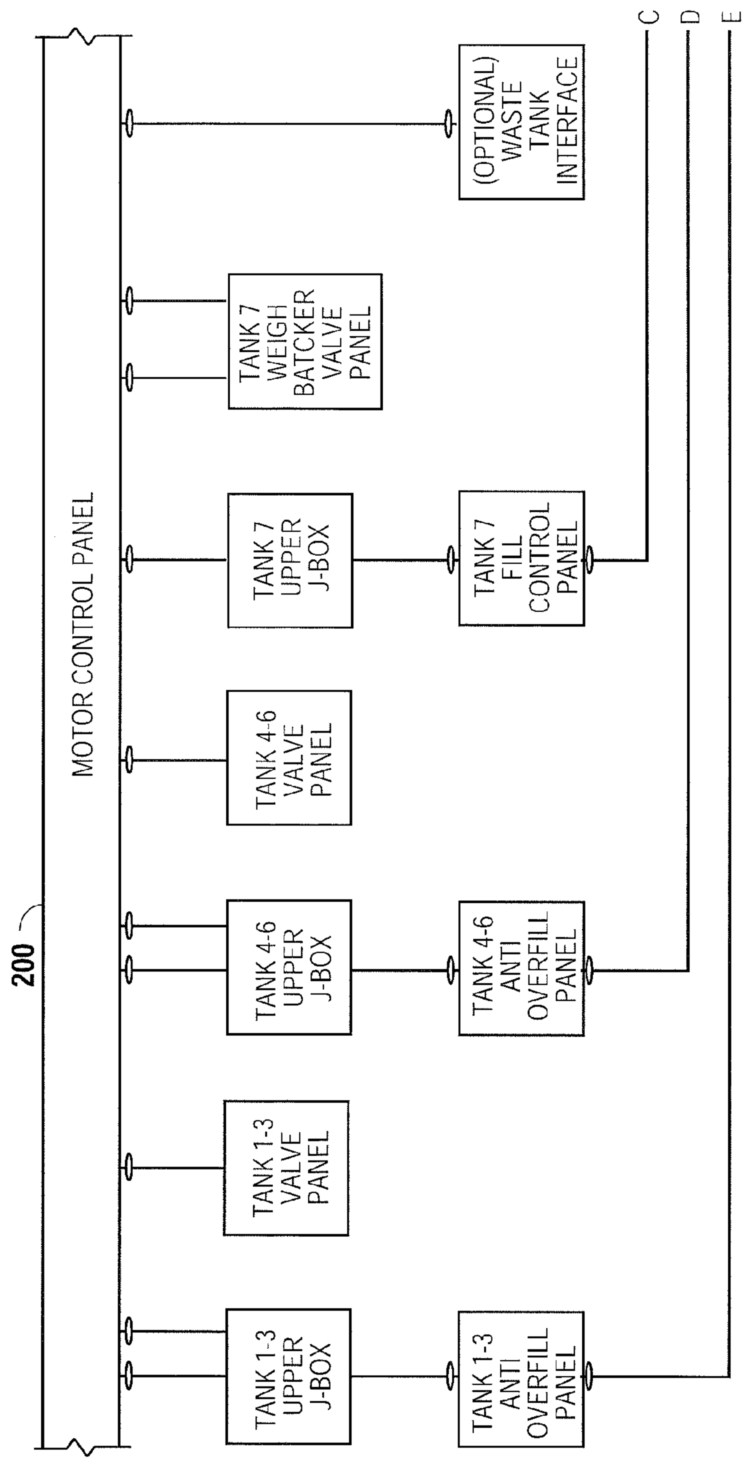
200
MOTOR CONTROL PANEL
TANK 1-3 UPPER J-BOX
TANK 1-3 ANTI OVERFILL PANEL
TANK 1-3 VALVE PANEL
TANK 4-6 UPPER J-BOX
TANK 4-6 ANTI OVERFILL PANEL
TANK 4-6 VALVE PANEL
TANK 7 UPPER J-BOX
TANK 7 FILL CONTROL PANEL
TANK 7 WEIGH BATCKER VALVE PANEL
(OPTIONAL) WASTE TANK INTERFACE
C
D
E

Fig. 8e

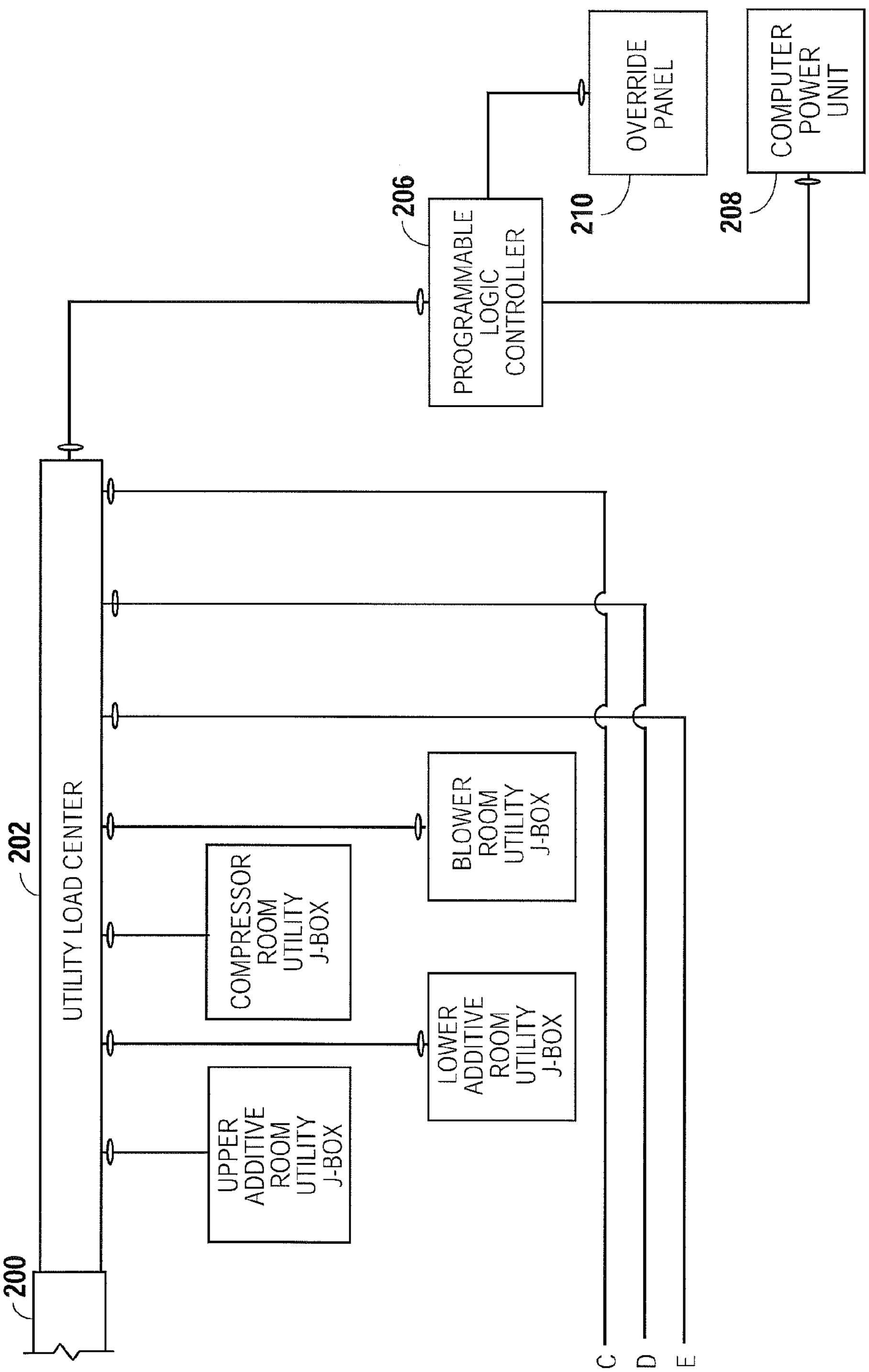
200
202
UTILITY LOAD CENTER
UPPER ADDITIVE ROOM UTILITY J-BOX
LOWER ADDITIVE ROOM UTILITY J-BOX
COMPRESSOR ROOM UTILITY J-BOX
BLOWER ROOM UTILITY J-BOX
206
PROGRAMMABLE LOGIC CONTROLLER
210
OVERRIDE PANEL
208
COMPUTER POWER UNIT
C
D
E

Fig. 8f

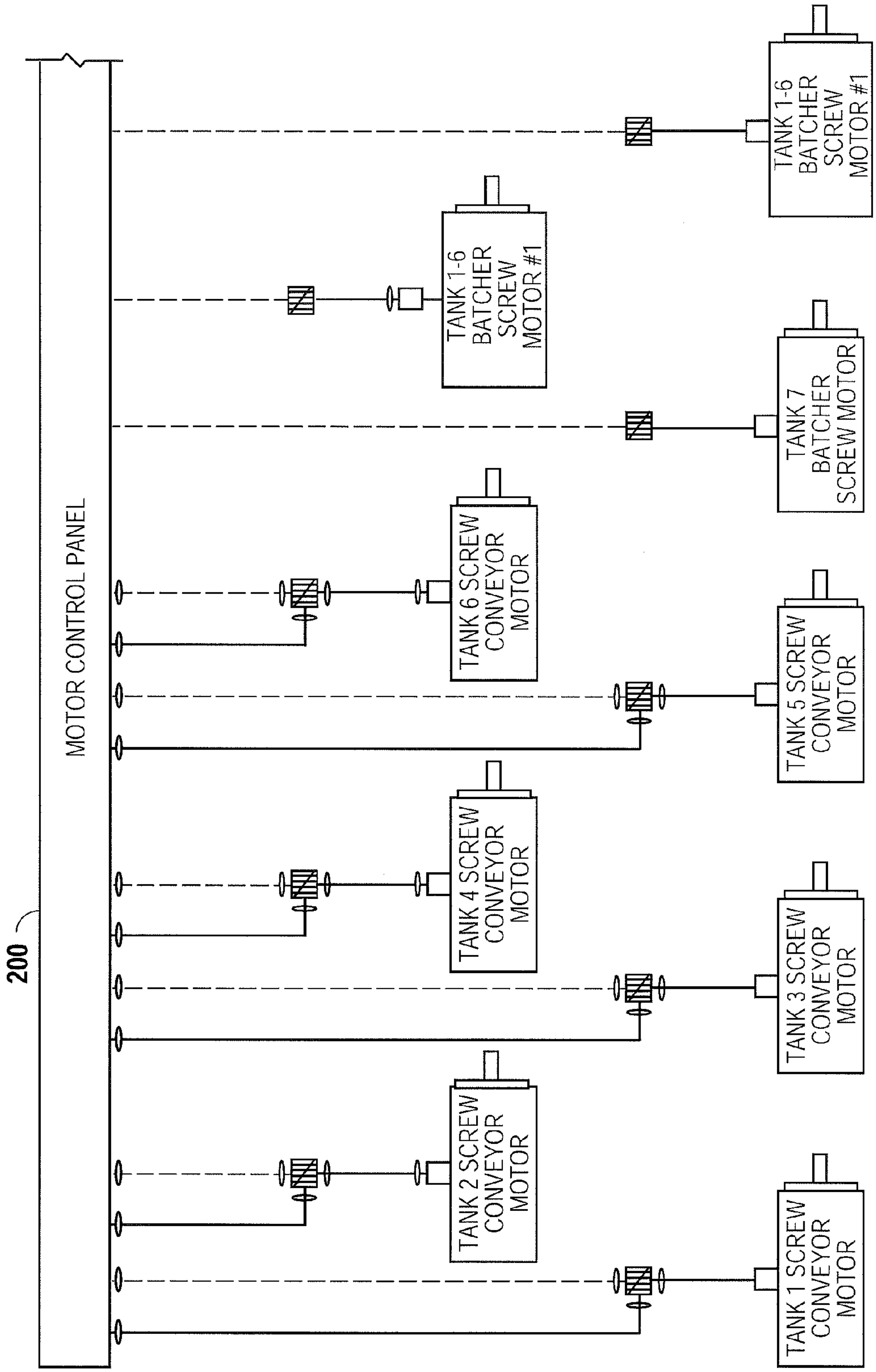
200
MOTOR CONTROL PANEL
TANK 1-6 BATCHER SCREW MOTOR #1
TANK 1-6 BATCHER SCREW MOTOR #1
TANK 7 BATCHER SCREW MOTOR
TANK 6 SCREW CONVEYOR MOTOR
TANK 5 SCREW CONVEYOR MOTOR
TANK 4 SCREW CONVEYOR MOTOR
TANK 3 SCREW CONVEYOR MOTOR
TANK 2 SCREW CONVEYOR MOTOR
TANK 1 SCREW CONVEYOR MOTOR

Fig. 8g

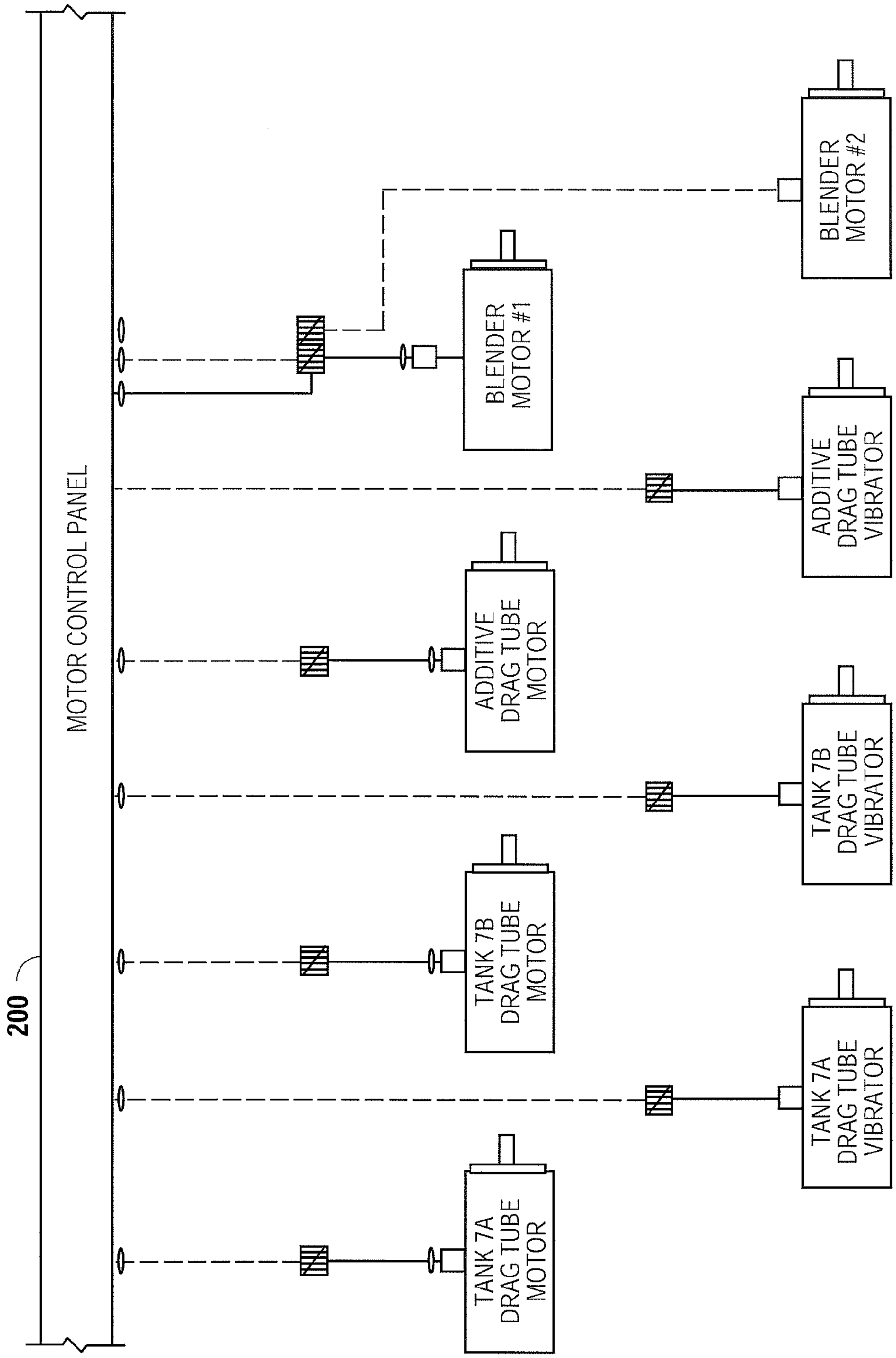
200
MOTOR CONTROL PANEL
BLENDER MOTOR #2
BLENDER MOTOR #1
ADDITIVE DRAG TUBE VIBRATOR
ADDITIVE DRAG TUBE MOTOR
TANK 7B DRAG TUBE VIBRATOR
TANK 7B DRAG TUBE MOTOR
TANK 7A DRAG TUBE VIBRATOR
TANK 7A DRAG TUBE MOTOR

Fig. 8b

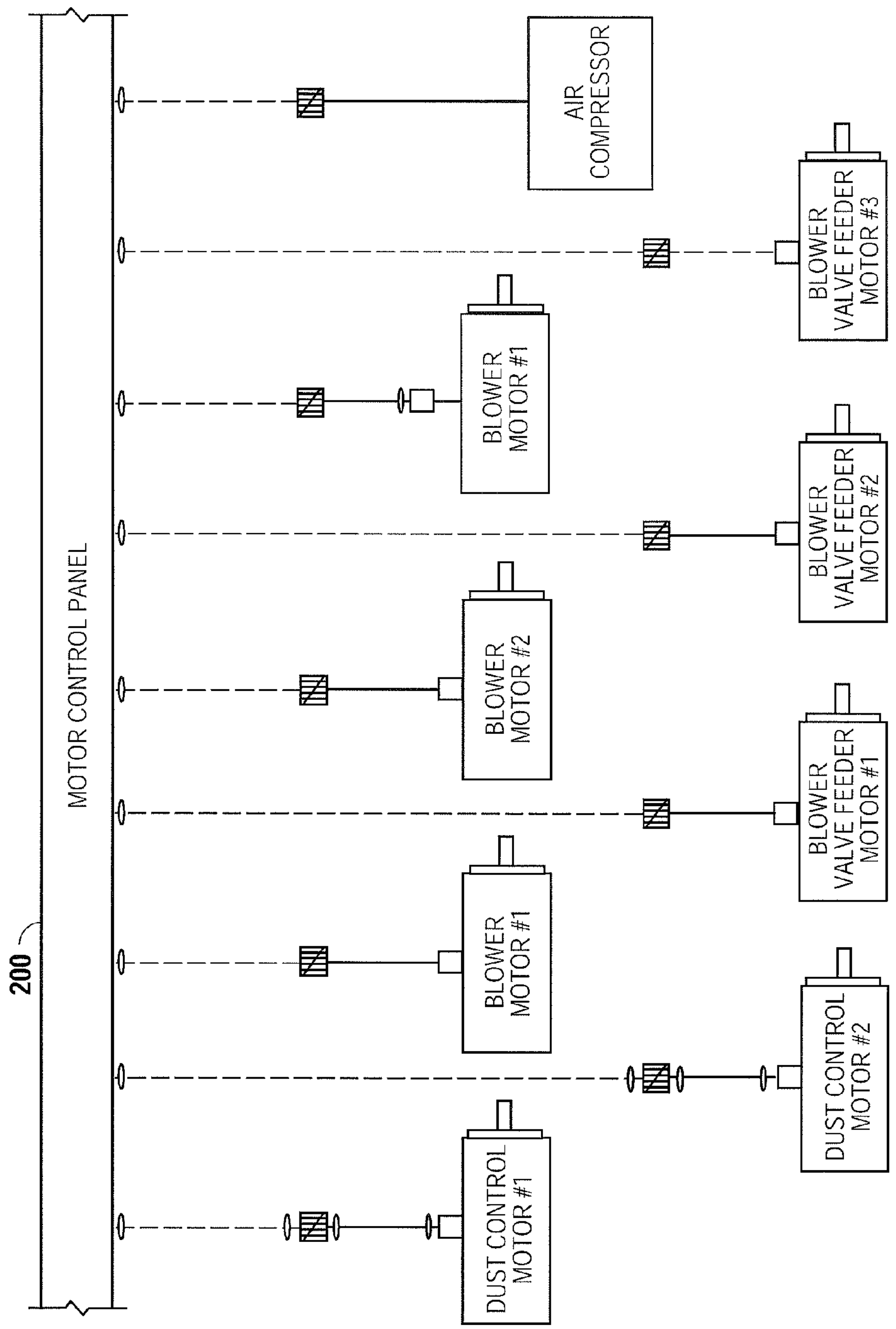
200
MOTOR CONTROL PANEL
AIR COMPRESSOR
BLOWER VALVE FEEDER MOTOR #3
BLOWER MOTOR #1
BLOWER VALVE FEEDER MOTOR #2
BLOWER MOTOR #2
BLOWER VALVE FEEDER MOTOR #1
BLOWER MOTOR #1
DUST CONTROL MOTOR #2
DUST CONTROL MOTOR #1

Fig. 8i

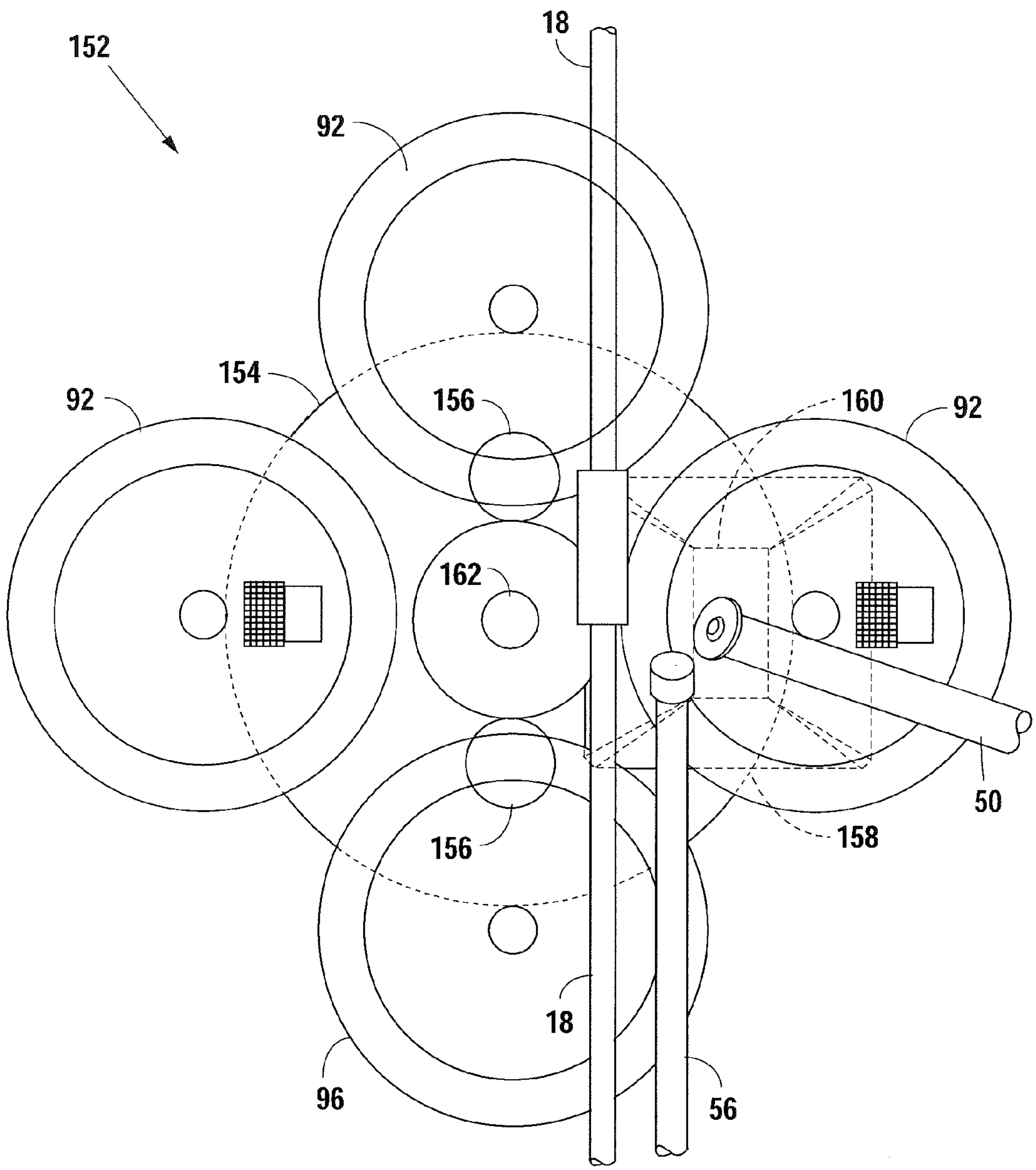

Fig. 9

ATMOSPHERIC STORAGE MECHANICAL WEIGHT BATCH BLENDING PLANT

FIELD OF THE INVENTION

The present invention relates to a dry cement batching and blending plant, and more particularly, to a portable dry cement batching and blending plant that will accurately measure and completely blend the ingredients of dry pre-made cement mixtures, which are then mixed with water at the well site for the oil & gas drilling and fracturing industry.

BACKGROUND OF THE INVENTION

A practice of using cement in the oil industry began around 1903 in California in an attempt to stop water from flowing into the oil well, and oil and gas from entering the waterways (aquifers). In those early years, cement was hand mixed and run into a dump baler to the spot needing to be plugged. Pumping cement, which would be mixed with water, down a well was soon also recognized as beneficial to encase the well and achieve a safer and more efficient operation of the drilling process. A forerunner of the modern two (2)-plug method was first used in 1910. The two (2) plugs minimize mud contact with the cement. Although both mechanical and chemical improvements have been made in a cementing process, the original plug concept is still valid today.

Erle Halliburton cemented a well in Oklahoma's Hewitt Field in 1920. The dry blending of oilfield cements is attained by many means, but the most prevalent remains the pneumatic transfer of the individual constituent parts of cements and additives, which are moved from pressure vessel to pressure vessel. This remains very similar to what was developed in the 1920's. These moves are often layered or "pancaked" to affect somewhat of a blend when then transferring to the next in a series of tanks. This type of mixing is referred to as "moves". Moves result in a very unscientific and haphazard blending methodology, as the differing specific gravities and molecular makeup of the varies constituent materials including various cements, bulk powder additives and granulated minerals and chemicals, are not easily comingled. Cement blends produced in this manner are highly dependent on the experience and attention of the blend plant operator. Numerous problems have been encountered with variations in such un-uniform blending which results in the ununiformed blends needing to be "spiked" or modification of the cement blends at the well site prior to mixing with water to get a properly performing and more complete mixture. A poor cement blend mixture can cause many problems including poor set strength, inadequate cement bond, blowouts, poor formation fracing or lack of mud displacement, which in the least presents environmental hazards, and losses in productivity, and in the worst cases can result in severe injury and loss of life due to blowouts and resulting explosions and fire.

Because of the inconsistencies in the mix cement product, many oilfield operators have gone to "pod" or "batch mixing". In the pod or batch mixing, all of the ingredients for the cement are put inside of a mixer and stirred together. This mix of blended cement is taken either in a slurry form or a powder form to the wellhead. At the wellhead, if it's in the powder form, water is added as the slurry is injected into the well. The using of pod or batch plants solved to some degree the cementing problems at shallow depths.

However, over the years, many different types of cements have been developed. The American Petroleum Institute recognizes Class A through Class J of different types of cements. When deciding upon cement job not only does a type of cement have to be selected, but so does the various additives. Many different additives have developed over the years. Oil wells have gotten deeper and deeper, and in recent years drilling is both vertical and horizontal, so the cementing occurs at higher pressures and higher temperatures, and the correct cement blend or mixture becomes more and more critical. Each well service company provides its own particular blend or "recipe" for their cement jobs, especially cement used at depths of 10,000 feet or more and are expected by well owners to provide a high level of quality assurance of high-performing well encasement with the pre-blended cements. The invention allows the utmost in quality assurance to the well service contractor, the well owner, landowner, and the community as a whole, while protecting the well rig workers and the environment.

For the blends used at high pressures and temperatures, it becomes important to completely mix (1) large volumes by weight items in the pre-blended dry cements, (2) intermediate volumes by weight of some items in the pre-blended dry cements, and (3) small volumes by weight of additives in the pre-blended cements. All of these must be perfectly pre-blended together to give the ideal cement blend at the well site prior to mixing with water or other fluids. If the ideal dry cement pre-blend is not reached and the cements and additives are not properly applied, blowouts can occur such as the BP Petroleum blowout that occurred in the Gulf of Mexico in 2010. Since the catastrophic BP blowout, more and more attention has been given to the accuracy of the pre-blend of cement being used, especially in deep wells, and in fracturing of wells, and also on offshore drilling.

In an attempt to solve the problem of inadequate pre-blending of oilfield cement, many of the larger companies have developed their own system or techniques. For example, Schlumberger Technology Corporation in U.S. Pat. No. 7,464,757, shows a batch mixing facility to deliver homogenized mixing slurry to a well pumping system, but this mixing can only affect the water/fluid-cement ratios and homogenize the mixture with the fluid, and does nothing to affect the imbalance of poorly pre-blended dry cements delivered to the well mixer out of specification of the recipes and safety requirements.

One of the problems with the prior systems is when water is added to the cement mixture, the resulting slurry can only be as good as the dry pre-blend, which at present is most unscientific and haphazard resulting in varying quality and unknown performance of the well encasement.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an apparatus to give a measured, dry, and completely pre-blended oilfield cement and additives recipe that can be substantiated in a controlled and measurable fashion as to provide expected performance when mixed with fluids at the well site.

It is another object of the present invention to provide a method for weigh-batching and exacting measurement of all constituent materials making up the oilfield cement according to a predetermined formula—by a computerized and controlled method.

It is yet another object of the present invention to provide a portable pre-blend dry oilfield cement plant that can accurately blend a dry cement to a measurable quantity by weight according to a predetermined formula.

It is yet another object of the present invention to provide a portable blending plant that can blend a dry cement mixture that has (1) bulk ingredients, (2) intermediate ingredients and,

(3) small amount ingredients, each being measured by weight, into a complete pre-blend as to allow for multiple small parts to be thoroughly interspersed throughout the mass of the pre-blend.

It is yet another object of the present invention to provide a blender that can blend large quantities of dry cement mixtures to provide a completely blended homogeneous dry pre-blended bulk ready-to-mix specialized cement for mixing with fluids at the wellhead.

In the blending plant a collection of bulk storage tanks are arranged around a weigh batcher. Mechanical screw augers connect from each of the bulk storage tanks to the weight batcher to provide an automated and recordable dosing of each constituent bulk powder to be blended. The weigh batcher measures by weight a predetermined quantity from selected bulk storage tanks. The measured quantities are then fed to a mechanical blender of a batch-type providing for a consistent and recordable quantity and batch number allowing for traceability and subsequent quality assurance practices so badly required in oilfield well encasement practices to date.

Intermediate quantities of ingredients for the cement blend are also weighed and fed into the blender. The intermediate quantities are normally delivered in bulk sacks or bags, rather than in truckloads as for the bulk storage tanks.

Also, small amounts of ingredients to be added to a cement mixture are also weighed and delivered to the blender through a drag tube conveyor—nothing is left to hand-add measurements or human error in the invention. The blending plant then automatically and thoroughly mechanically blends under only atmospheric conditions all of the dry ingredient-types (large, intermediate and small in quantities) into a dry homogeneous pre-blend. As soon as the blending is complete, the blender dumps the batch into appropriate weighed and automatically inventoried containers; and starts the blending process begins again in a cycle basis to automatically pre-blend a prescribed total pre-blend quantity of several tons for shipment by bulk transport truck or specialized oilfield bottle truck chassis to the well site.

Because the dry cement blend is very abrasive it can damage the bearings on any blender shaft used in a horizontal shaft equipped blender. Also, because any lubricant, such as grease, coming into contact with the cement blend can damage the cement blend, a special bearing was designed that uses pressurized air to (a) keep the cement mixture out of the bearing and (b) provide an air cushion on which the bearing will turn.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an illustrated perspective view of an atmospheric mechanical weigh batch blend plant.

FIG. **2** is a top view of FIG. **1**.

FIG. **3** is a perspective view of the blender used in FIGS. **1** and **2**.

FIG. **4** is an illustrated perspective view of the mini batch portion of the weight batch blend plant shown in FIGS. **1** and **2**.

FIG. **5** is a perspective view of the weigh vessel for measuring intermediate quantities of cementing ingredients of the weight batch blend plant shown in FIGS. **1** and **2**.

FIGS. **6**A and **6**B are illustrated flow diagram of the weigh batch blend plant shown in FIGS. **1** and **2**.

FIG. **7** is a cross-sectional view of a bearing used in the blender shown in FIG. **3**.

FIG. **8** is an illustrated flow diagram of the atmospheric storage mechanical weigh batch blend plant.

FIGS. **8***a* through **8***i* illustrate electrical controls for the atmospheric storage mechanical weigh batch blend plant of FIG. **8**.

FIG. **9** is a top view of an alternative vertical blender.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. **1** and **2** in combination, an atmospheric storage mechanical weigh batch blend plant, representing by reference numeral **12**, is shown. All of the ingredients of the cement recipe are mechanically forced together inside of the blender **14**.

1. Bulk Materials

The larger constituent quantities of materials that are needed in a dry pre-blended cement, which are referred to as bulk materials, are stored in atmospheric bulk storage tanks **20**A-**20**F. Bulk materials are received from bulk weigh batcher **16** via dual screw transport augers **18**. Mechanical screw augers **22**A-**22**F feed preselected bulk materials from either bulk storage tanks **20**A-**20**F, respectively, into the bulk weigh batcher **16**. Only preselected amounts of each bulk material from bulk storage tanks **20**A-**20**F is fed into the bulk weigh batcher **16** as is determined by weight. Thereafter, the weighed amount of each bulk material from bulk storage tanks **20**A-**20**F is fed via dual screw auger **18** into the blender **14**.

Each of the bulk storage tanks **20**A, **20**C, **20**D and **20**F contain a single bulk material and have dust collectors **24** on the top thereof. When the bulk storage tanks **20**A, **20**C, **20**D and **20**F are being filled via vortex elbows **26** and air inside of the bulk storage tank **20** is being displaced, dust collectors **24** prevent dust from being discharged to the atmosphere.

Referring to bulk storage tanks **20**B and **20**E, these tanks are split down the middle by dividing wall (not shown) so they can store two different bulk materials. Therefore, two dust collectors **28** and **30** are required as well as two vortex elbows **32** and **34** for split bulk storage tanks **20**B and **20**E.

The use of the weigh batcher **16** with the mechanical screw augers **22** where a large amount of the bulk material contained in bulk storage tank **20** may be used, the large amount of material can be accurately weighed and fed through dual screw augers **18** into the blender **14**.

2. Intermediate Materials

In a typical blend of dry cement that is to be used in deep wells with high pressure and temperatures, there will probably be some intermediate materials by weight in the mix. By intermediate there will not be as much as the bulk materials, but will be more than small amounts. The intermediate materials normally come in bulk bags rather than by the truckloads. The intermediate materials are storage in intermediate storage tank **36** that has a divided wall **38** to divide the intermediate storage tank **36** into two separate halves for two different intermediate materials to be included in the dry mixed cement. Each side of the intermediate storage tank **36** has a bulk bag unloader **40**A and **40**B. The bulk bag unloaders **40**A and **40**B connect to drag tubes **42**A and **42**B, respectively, that delivers the intermediate material to the respective sides of the intermediate storage tank **36** via discharge valves **44**A and **44**B, respectively.

When the intermediate storage tank **36** is being filled up, dust collectors **46**A and **46**B insure that no dust is discharged to the atmosphere as air inside of the intermediate storage tank **36** is displaced.

If the particular recipe calls for some of the intermediate materials contained in intermediate storage tank **36**, the intermediate materials are discharged to a weigh vessel **48** contained there below (see FIG. **1**). The weigh vessel **48** measures by weight an accurate amount of the intermediate material called for from the intermediate storage tank **36**. Once properly weighed, the intermediate materials are moved by mechanical screw auger **50** to the blender **14**.

3. Adding Small Amounts to Mixture

As wells are getting deeper, temperatures increasing and pressures increasing, a number of additives are combined in the recipe in small amounts. The additives could perform many of the following functions:

1. Being an accelerator to shorten the setting time;
2. Be a retardant that lengthens the setting time;
3. Increase the density (weight) of the cement blend;
4. Decrease the density of the cement;
5. Change the compressive strength of the cement;
6. Change the flow properties of the cement;
7. Change the dehydration rate of the cement;
8. Extend the cement to decrease the cost of cementing;
9. Be an anti-foam additive to prevent foaming;
10. Include bridging material to plug lost circulation zones.

The above listing is just a typical listing of the functions of various additives that maybe included in the cement blend recipe. For the materials that are added in small amounts, also called "additives", the additives are added in the mini batch facility **52**, which is shown in more detail in FIG. **4**. The mini batch facility **52**, has a series of weigh vessels **54**A-**54**C in which small amounts of an additive can be accurately weighed and then fed into the drag tubes **28**.

Sometimes it is necessary to add an additive by hand, either because it is such a small amount or a decision was made at the last minute to include another additive. In that case, a hand add-on station **58** is provided where the addition can be weighed as added by personnel operating the plant, by hand, on scale **60** and added through the hatch **62**. The small additives are delivered via the drag tubes **56** to the blender **14**. The drag tube **56** moves the small amounts (additives) through a discharge housing **64** where the additives drop through additive tube **66** into the blender **14** (see FIG. **3**).

By use of these three separate weighing systems, (1) for the bulk materials, (2) intermediate materials, and (3) the small additives, a very accurately measured dry cement material is delivered to the blender **14**.

Referring now to FIG. **3**, a large view of blender **14** is shown. The bulk materials are fed into the blender **14** through the dual screw augers **18**. The intermediate materials are fed into the blender **14** through the mechanical screw augers **50**. The small amounts additives are fed into the blender **14** via the drag tubes **56**, discharge housing **64** and additives tube **66**. A vent **68** that has dust collection therein, allows any air inside of the blender **14** to be displaced as the materials are added.

The blender **14** is a dual shaft blender with two shafts **70** extending horizontally through the blender. Specially designed bearings **72** are on each end, as will be discussed subsequently, of the shafts **70**. The shafts **70** are turned by blender motor **74** (see FIG. **2**). Extending from the top the blender **14** is ducting **76** that provides displaced atmosphere containing dust to be scavenged in a dust collection device called the blender scavenger—a pollution control device.

Referring now to the mini batch facility **52** is shown in FIG. **4**, enlarged view of the weigh vessel **54** is shown in FIG. **5**. The weigh vessel **54** is on a stand **78** with the drag tubes **56** (see FIGS. **1**, **2**, and **4**) extending there below. The exact amount of a small additive that is desired is fed into the weigh vessel **54** through opening **80** and then discharged into the drag tubes **56**. The weigh vessel **54** ensures that exactly the right amount of an additive is fed into blender **14** for the correct mixture or "recipe" for the dry pre-blended oilfield cement.

Referring to FIGS. **6**A and **6**B, a pictorial flow diagram of the various functions on the weigh batch blend plant **12** are shown. The same reference numbers as previously used will be used again, plus new reference numbers for new items. To the far left of FIG. **6**A is the intermediate storage tank **36** with dust collectors **46**A and **46**B being located there above. The dividing wall **38** separates intermediate storage tank **36** into two halves. Bulk bags un-loaders **40**A and **40**B are used to load the intermediate storage tank **36** with the intermediate materials that are normally delivered in bulk bags. Mechanical screw **50** is used to deliver the intermediate materials to the hopper **82** of the blender **14**.

Depending upon the number of intermediate materials that need to be introduced into the blend, a number of intermediate storage tanks can be increased as the desired. A typical number would be two (2) intermediate storage tanks **36** each having two halves, which would then accommodate a total of four different intermediate materials for the concrete blend—although this number may be reduced or added to accordingly as to accommodate blend recipes as required.

Weigh vessel **54** is used to put small amounts of additives into the concrete blend. Any number of weigh vessels **54** as is shown in mini batch facility **52** (see FIG. **4**) can be added as needed. The additives are fed through drag line **56** into the blender **14**. In a typical example there may be approximately four (4) weigh vessels **54**.

The larger amounts of material that are delivered by truckloads will be stored in bulk storage tanks **20**. Dust collectors **24** keep the discharge of dust from the bulk storage tanks **20** from getting into the atmosphere during loading and unloading. Materials delivered from bulk storage tanks **20** are weighed in a bulk weigh batcher **16** (see FIG. **2**), then delivered via dual screw auger **18** to the hopper **82** of the blender **14**.

Inside of the blender **14**, the various ingredients of the dry cement recipe are blended together by dual shafts (not shown in FIGS. **6**A and **6**B) being turned inside of the blender **14** by motors **74**. After the dry cement recipe is completely blended, together with all various additive and constituent materials, it is discharged by gravity from the blender **14** into ready mix hopper **84**. When the product in the post-blend hopper **74** is completely blended (oilfield terminology to describe the mixture before water is added to form slurry is "pre-blend"), the pre-blend as contained in the pre-blend hopper **84** may be delivered to transport vehicle via transport conduit **86** or to pre-blend storage via storage conduit **88**. If the pre-blend is to be stored, the storage conduit **88** connects to fill valves **90** of pre-blend storage tanks **92**. From the pre-blend storage tanks **92** the pre-blend contained therein may be loaded onto transport vehicles at the desired time via control valves **94** and discharge ducts **96**.

For almost all recipes of oil field cement blends for a particular formula, when switching to a different formula or recipe, there will be remnants of the prior mixture. To handle these remnants is a reclaimed storage tank **98**. For example, if the blender **14** has remnants of a dry cement pre-blend therein when switching to a different blend, those remnants are pumped via reclaim line **100** to reclaim storage tank **98**. If a transport vehicle has remnants remaining therein, they can also be pumped via reclaim valve **102** to the reclaim storage tank **98**.

Likewise, if there are remnants left in pre-blend storage tanks **92** by pressurizing the pre-blend storage tanks **92** with compressor **104**, any remnants remaining therein can be pumped via reclaim line **100** by opening pre-blend reclaim valves **106** via reclaim line **100** into reclaim storage tank **98**. Reclaim dust collector **108** prevents any dust during the reclaim process from being discharged to atmosphere.

To get rid of reclaim materials contained in the reclaim storage tank **98**, the compressor **104** pressurizes the reclaim storage tank **98** which then forces the reclaimed material out discharge control **110** for delivery through transport ducts **112** for disposal. If it becomes necessary for the reclaim storage tank **98** to vent to atmosphere, reclaim dust collectors **114** will ensure no dust is discharged to atmosphere.

Referring now to FIG. **7**, the specially designed bearing **72** for the shafts **70** of the blender **14** is explained in further detail. The specially designed bearing consists of an annulus **116** being bolted to the blender housing **118** by bolts **120** pressing plate **122** against the annulus **116**.

Through the annulus **116** is a pressurized air fitting that connects via air duct **126** to the shafts **70** to feed pressurized air from the compressor **104** (see FIG. **6**B) via the air duct **126** to the surface between bearing **128** and shaft **70**. This means there is a cushion of air between bearing **128** and shaft **70**. Also the pressurized air keeps the material being mixed from getting into the area between bearing **128** and shaft **70**. The shaft **70** is literally riding on a cushion of air.

Referring to FIG. **8**, a pictorial flow representation of the atmospheric storage mechanical weigh batch plant **12** as explained in FIGS. **1** and **2** is shown. Where possible, like numbers as used for FIGS. **1** and **2** will be used in FIG. **8**. However, FIG. **8** will have additional reference numbers and explanations where necessary. The bulk storage tanks **20**A-**20**F feed through conveyors **22**A-**22**F, respectfully, into bulk weigh batcher **16**. Delivery of bulk material from bulk storage tanks **20**A, **20**C, **20**D and **20**E is controlled by butterfly valves **130**. Because bulk storage tanks **20**B and **20**E are split tanks pneumatic actuated butterfly valves **132** are used. The bulk weigh batcher **16** has load cells **134** to accurately measure the amount of bulk material that has been received. Once the proper amount of material has been received into the bulk weigh batcher **16**, it is then delivered via dual augers **18** to the blender **14**. The bulk weigh batcher **16** handles the large quantities of materials that would typically be used in a dry oilfield cement mixture. The quantities being handled by the bulk weigh batcher **16** are larger quantities (percentagewise) of the dry oilfield cement mixture.

At the intermediate storage tanks **36**, bulk bags un-loaders **40**A and **40**B receive the bags of material which bags of material are dumped into an intermediate storage tank **36** via drag tubes **42**A and **42**B.

Below the intermediate storage tank **36** are pneumatic actuated butterfly valves **136** which controls the amount of intermediate material being delivered to the weigh vessel **48** as determined by load cells **138**. When the proper amount of intermediate material has been received into the weigh vessel **48**, pneumatically actuated butterfly valve **140** is opened and the intermediate material is delivered through mechanical screw auger **50** to the blender **14**. The term "intermediate" refers to amounts by weight that is considerably less than the materials delivered by the bulk weigh batcher **16**, but are much greater than the small additives typically mixed into a dry oilfield cement blend.

The mini batch facility **52** as is illustrated in FIG. **8**, has a series of weigh vessels **54**A-**54**C that can accurately measure small amounts of additives and deliver those small amounts of additives via pneumatically actuated butterfly valves **142** through the drag tube **56**. The drag tube **56** will deliver the small amounts of additives to the blender **14**.

Also the mini batch additive weighing portion of the overall facility **52** will have a hand weigh batcher **58** for the hand adding of small amounts of various additives. The hand amounts also feed through one of the pneumatically actuated butterfly valves **142** into drag tube **56**. Each of the weigh vessels **54**A-**54**C has an opening **80** through which the small amounts of additives can be stored. Even the hand weight batcher **58** has a vessel **144** in which to store small amounts of additives. The mini batch facility **52** adds the small portions by weight of materials that are necessary for the dry oilfield cement blend.

After the blender **14** has thoroughly forced the dry materials, into a blend, the dry oilfield cement blend is discharged into a post blend hopper holding pre-blended material **84** for either storage or delivery to the well site. Blowers **146** may be used to move the dry pre-blend oilfield cement in hopper **84** typically referred to as "pre-blend", to either the transport vehicle (not shown) or a storage vessel **148**. The storage vessel **148** could be the same as the pre-blend storage tanks **92** as illustrated in FIG. **6**B. The compressor **104** provides compressed air as needed particularly in operating various pneumatic valves.

Turning to FIGS. **8***a* and **8***b*, the illustrative flow diagram of the atmospheric storage mechanical weigh batch blend plant of FIG. **8** is given along with the legends for each of the items illustrated being listed in FIG. **8***c*. In this manner, each of the items shown in FIGS. **8***a* and **8***b* are controlled as illustrated in FIG. **8***a* by each of the items as shown in the legend of FIG. **8***c*. For example, any of the mechanical functions are illustrated by symbols as are contained in the legend of FIG. **8***c*, such as "load cells", "pneumatic actuator", "slide gate", just to name a few. The illustrative flow diagram as shown in FIGS. **8***a* and **8***b* is the type an engineer would use. FIG. **8***c* is the legend that goes with FIGS. **8***a* and **8***b*.

Referring to FIGS. **8***d* through **8***i* in combination, the electrical connections to FIGS. **8***a* and **8***b* are illustrated. Each of the tanks as illustrated in FIGS. **8***a* and **8***b* have the same numerical reference in FIGS. **8***d* and **8***i*. A motor control panel **200** is used to operate all of the controls as illustrated in FIGS. **8***a* and **8***b*. A description of the item being operated is given in each of the blocks connected to the motor control panel **200**. While a part of the motor control panel **200**, the utility load center **202** controls specific parts of the weigh batch blend plant.

Also connected to the motor control panel **200** is additive scale panel **204**, which is used to add the small amounts added to the blend. Use of the term "J-box" as contained in FIGS. **8***d* and **8***i* is referring to an electrical junction box.

The entire operation is run by a programmable logic controller **206** shown in FIG. **8***f*, which programmable logic controller **206** sets the recipe being used into the weight batch blending plant. Through the use of the programmable logic controller **206**, the recipe can be changed according to the desires of the operator. In one particular oil field, the recipe for the cement may be different than in a different oil field. Therefore, the recipe may have to be changed, depending upon where the end product is being used.

Power for the programmable logic controller **206** is provided by computer power unit **208**. It is important that the computer power unit **208** not be subject to power fluctuations and has a backup power source to maintain information in memory.

In case any portion of the program needs to be overwritten, an override panel **210** allows the operator to overrun any portion of the plant as is necessary. Through the use of the override panel **210**, if necessary, the entire plant could be run manually.

FIGS. **8**a-**8**i illustrate how a typical atmospheric storage mechanical weigh batch blend plant may be controlled.

Blower **150** may be used to move any of the dry materials when blending the various ingredients.

While the blender **14** as shown in FIGS. **1**, **2** and **3**, is a dual shaft horizontal blender, the blender also could be a vertical shaft blender **152** as illustrated in FIG. **9**. The vertical shaft blender **152** has a vertical vessel **154** with vertical shafts **156** extending there through. The vertical shafts **156** has paddles (not shown) thereon to blend the material contained within the vertical vessel **154**. The dry materials for the ready mix cement is delivered to the vertical vessel **154** via dual screw auger **18** of the large quantities of materials, mechanical screw auger **50** for the intermediate materials, and drag tubes **56** for the small amounts of additives. All of the materials are fed into the vertical hopper **158** or discharged through lower opening **160** into the vertical vessel **154**. After the appropriate amounts of the various ingredients are discharged through the vertical hopper **158** into the vertical vessel **154** and thoroughly blended therein, the "pre-blend" cement mix is discharged through discharge opening **162** into one of the pre-blend storage tanks **92**.

Typically, a vertical shaft blender **152** will be used for smaller batches, but a horizontal shaft blender such as blender **14** is used for larger batches.

What I claim is:

1. An atmospheric storage batch-type blend plant for providing a dry, pre-blended, cement prepared according to a recipe for use in oil well encasement, said batch blend plant comprising:

a blender for receiving measured, dry materials to be thoroughly blended into a an accurate pre-blend, the blender having a blender housing, a shaft protruding from the housing, and a bearing assembly attached to the blender housing and surrounding part of the shaft;

a plurality of bulk storage tanks;

a bulk weigh batcher for measuring by weight bulk materials from said plurality of bulk storage tanks;

bulk delivery device for delivering said bulk materials from said bulk weigh batcher to said blender;

an intermediate weigh vessel for measuring by weight intermediate materials from intermediate storage tanks;

an intermediate delivery device for delivering said intermediate materials from said intermediate weigh vessel to said blender;

mini batch weigh vessels for measuring by weight small amounts of additives;

an additives delivery device for delivering small additives after said measuring to said blender;

said bulk weigh batcher measuring large quantities by weight, said mini batch weigh vessels measuring small quantities by weight and said intermediate weigh vessel measuring intermediate quantities by weight, all of which are mixed together to give said pre-blend;

pre-blend containers for receiving said pre-blend after the weighing and blending of said recipe of said bulk materials, said intermediate materials and said small amounts of said additives in said blender; and

a source of pressurized air being connected to said bearing assembly to provide said pressurized air between bearings in said bearing assembly and said shaft to prevent abrasive materials from getting between said bearings and said shaft.

2. The atmospheric storage batch-type blend plant for providing said dry, pre-blended, cement prepared according to said recipe for use in oil well encasement as recited in claim **1** wherein said bulk delivery device is a bulk screw auger and intermediate delivery device is an intermediate screw auger.

3. The atmospheric storage batch-type blend plant for providing said dry, pre-blended, cement prepared according to said recipe for use in oil well encasement as recited in claim **2** wherein said additives delivery device is drag tubes.

4. The atmospheric storage batch-type blend plant for providing said dry, pre-blended, cement prepared according to said recipe for use in oil well encasement as recited in claim **3** wherein said blender is a dual shaft horizontal blender with paddles being attached to said shafts.

5. The atmospheric storage batch-type blend plant for providing said dry, pre-blended, cement prepared according to said recipe for use in oil well encasement as recited in claim **4** comprising a bag un-loader for unloading bags of said intermediate material into said intermediate storage tanks.

6. The atmospheric storage batch-type blend plant for providing said dry, pre-blended, cement prepared according to said recipe for use in oil well encasement as recited in claim **5** wherein said mini batch weigh vessels includes a hand additive weight station for hand measuring hand weighted additives to be delivered to said blender via said drag tubes.

7. The atmospheric storage batch-type blend plant for providing said dry, pre-blended, cement prepared according to said recipe for use in oil well encasement as recited in claim **3** wherein said blender is a vertical shaft blender.

8. The atmospheric storage batch-type blend plant for providing said dry, pre-blended, cement prepared according to said recipe for use in oil well encasement as recited in claim **6** or **7** wherein containers for such pre-blend are pre-blend storage tanks.

9. The atmospheric storage batch-type blend plant for providing said dry, pre-blended, cement prepared according to said recipe for use in oil well encasement as recited in claim **8** comprising a reclaim storage tank for receiving leftover materials from said pre-blend for subsequent disposal.

10. The blend plant of claim **1** wherein said bearing assembly comprises:

a cylindrical bearing surface in said bearing surrounding part of the shaft;

an annulus circumscribing the bearing; and

a fitting connected to the annulus and having a fitting end connected to said source of pressurized air, wherein the fitting, the annulus and the bearing at least partially define an air duct between the fitting end and the cylindrical bearing surface.

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